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Candid Chats

Don't Be a Nagger

Results are what count, and as long as an engineer gets them quickly and efficiently, how he gets them is his own concern.

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Nothing on earth demoralizes an organization and takes the heart out of an engineer like a manager who is constantly changing his mind.

IF A MAN IS HIRED to fill a certain position, give him credit for having horse sense enough to run his own job, at least until he proves the contrary to be true.

By this is not meant that a manager is never to check up the work that his engineer is doing, but *results are what count, and as long as an engineer gets them quickly and efficiently, how he gets them is his own concern.*

No two humans were ever created exactly alike. Such being the case, it is seldom that any two will tackle a given proposition in the same way—and right there is the rub.

Give a man credit for a personality and ideas of his own, and don't tell him he is blundering the instant he deviates from a plan you had in mind. Forget the details. The chances are ten to one he knows more about them than you do, and anyway, your engineer is being paid for the express purpose of looking after them and relieving your shoulders of that burden.

Don't make an errand boy of him, or reduce him to such a state of indecision that he will come and ask if it will be all right to have a couple of men out Sunday to wash the boilers. Such tactics kill all the initiative an engineer possesses.

When you give instructions make them clear and concise and give them to the chief and not to some man under him, if you wish him to maintain any discipline and have the respect of his helpers; and before you give instructions settle in your own mind first, just what result you wish to attain and then stick to it.

Nothing on earth demoralizes an organization and takes the heart out of an engineer like a manager who is constantly changing his mind.

A man gets so he will exert no effort whatever to "make things hum," because he knows that as soon as he gets a piece of work nicely started, in will come the boss, change his mind and then a "patched up," "made over" job will be the result.

In other words, be consistent. Treat your chief engineer as if he were a man who knows his business, and don't nag him until his head is so busy thinking up new words to describe your special brand of ivory that he has no time to think of his plant, as the former kind of "thinks" don't help the coal pile.

[Contributed by Karl A. May, Kearsarge, Mich.

Addition to the Westport Power Plant

By Warren O. Rogers

SYNOPSIS—Owing to increased business the Westport power plant, the original capacity of which was 22,500 kw., has recently been enlarged by putting in a 15,000-kw turbine and six water-tube boilers, each with a heating surface of 10,470 sq.ft. The boiler furnaces are each equipped with an 11-retort underfeed stoker. A special design of jet condenser, so far as known, the largest built, is used with the new turbine, and is designed to take care of 200,000 lb. of steam per hour with a vacuum of 28.5 inches. The brick chimney is supported by steel girders and columns. The base of the chimney is level with the top of the boiler-room roof, 65 ft. above the ground level.

The electric and gas business in Baltimore, Md., is controlled by the Consolidated Gas, Electric Light & Power Co., and until three years ago nearly all of the electrical energy was generated at the company's steam plant at Westport, on the west bank of the Middle Branch of the Patapsco River. Prior to the addition the plant had a rated capacity of 30,000 hp.; a small steam plant of 8000-hp. capacity on Gould St. and a small water-power plant at Ilchester are also operated by the company.

Although the Westport plant, Fig. 1, is tied in with the McCalls Ferry* hydro-electric plant of the Pennsylvania Water & Power Co., this company is separate and distinct

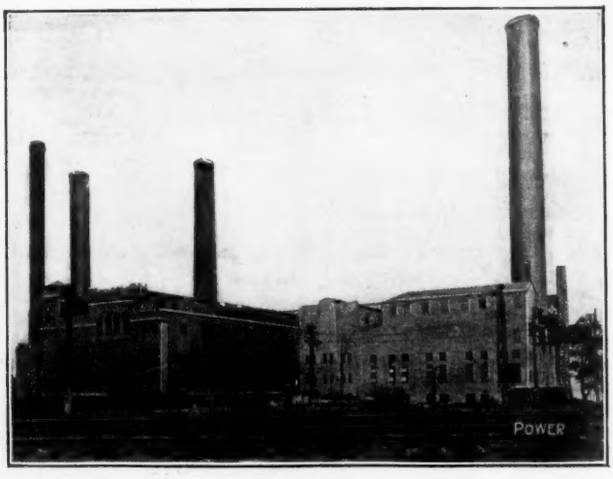


Fig. 1. Showing Addition to Westport Power House

as an organization, from the Consolidated Gas, Electric Light & Power Co. The former company, however, has a contract with the latter calling for the capacity of the latter's plant in case of failure to the hydro-electric station apparatus or transmission lines. This arrangement also applies to the United Railways Co., which has a steam plant of 26,000-hp. rating that is operated in an auxiliary capacity during the peak-load hours.

Since the contract was made with the Pennsylvania company the electric business of the Consolidated company has increased 150 per cent., being now 2½ times as great as three years ago. As a matter of prudence the Westport plant has been enlarged sufficiently to take care of its business in case of a breakdown of the water-power plant. The former equipment consisted of four 2500-kw., one 5000-kw. reciprocating units, as shown in

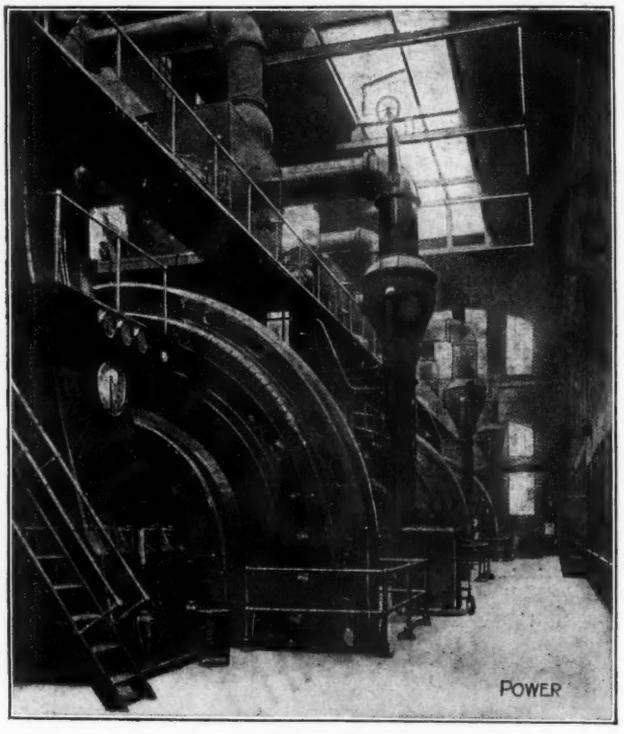


Fig. 2. View of the Old Engine Room, Westport Power House

Fig. 2, and a 7500-kw. turbine, or a total continuous capacity of 22,500 kw. The new 15,000-kw. turbine thus gives a station capacity of 37,500 kw. The old plant has a total in boiler heating surface of 120,000 square feet.

Turbine Room

The turbine room, which contains two horizontal turbines, adjoins the engine room shown in Fig. 2. The smaller turbine is a 7500-kw., 13,200-volt, three-phase, 25-cycle unit running at 1500 r.p.m. It occupies the space formerly taken up by a vertical turbine, recently discarded. The condensing apparatus of the original turbine is used with the newer unit and consists of two jet condensers, two 13x14-in. engine-driven 20-in. volute pumps for injection water, and two 8&10x24x24-in. dry-vacuum pumps, the steam ends of which are equipped with Corliss valve-gear. One of the condensers is shown in Fig. 3.

The 15,000-Kw. Unit and Condenser

The new 15,000-kw. unit is shown in the foreground of Fig. 4. It is a 13,200-volt, three-phase, 25-cycle, 1500-r.p.m. machine. The condenser for this unit is, as far as

*Described in the May 13, 1913, issue of "Power."

known, the largest jet condenser ever built. A partial view of one end is shown in Fig. 5 and a side view in Fig. 6. It is designed to take care of 200,000 lb. of steam per hour, at an absolute pressure of 1.5 in. with 70 deg. F. injection water, using 25,000 gal. per minute.

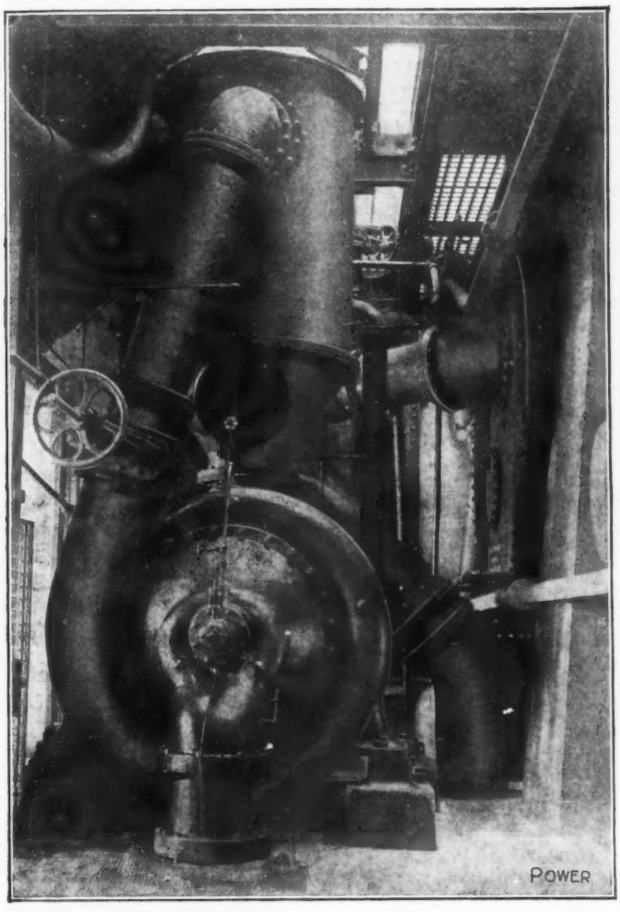


FIG. 3. ONE OF THE CONDENSERS USED WITH THE 7500-KW. TURBINE

The floor space available for the condenser and air pumps under the turbine and between the turbine foundation walls was 14x15 ft. This necessitated several departures from the usual design of jet condensers and demanded highly efficient apparatus.

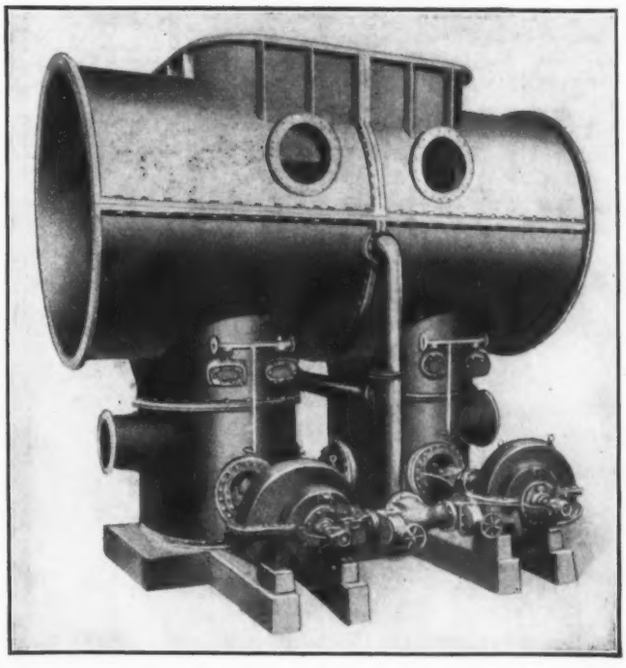


FIG. 6. LARGEST KNOWN JET CONDENSER, CAPACITY 200,000 LB. OF STEAM PER HOUR

The condenser consists of a horizontal cylinder 10 ft. in diameter and 20 ft. long, with a 7-ft. 6-in. by 10-ft. 9-in. rectangular flanged exhaust opening at the top and two 6-ft. diameter wells on 8-ft. centers at the bottom. These wells are bolted to a base plate with the condenser. The pumps are driven by two turbines mounted on independent base plates and are located below the generator and connected through extended shafts with flexible couplings. These turbines at their rated speed of 1050 r.p.m. develop 300 hp. each under full-load conditions.

To effect a balanced condition and uniform distribution, the injection water is taken in at each end of the condenser through two 24-in. pipes running through the condenser shell and bolted to each head. These pipes are fitted with brass nozzles which direct the water against spray plates; the water is further broken up by staggered trays with serrated edges, placed under the injection pipes. The air and noncondensable vapors are removed from the condenser at each side. This arrange-

FIG. 4. GENERAL VIEW OF THE TURBINE ROOM FROM THE TRAVELING CRANE

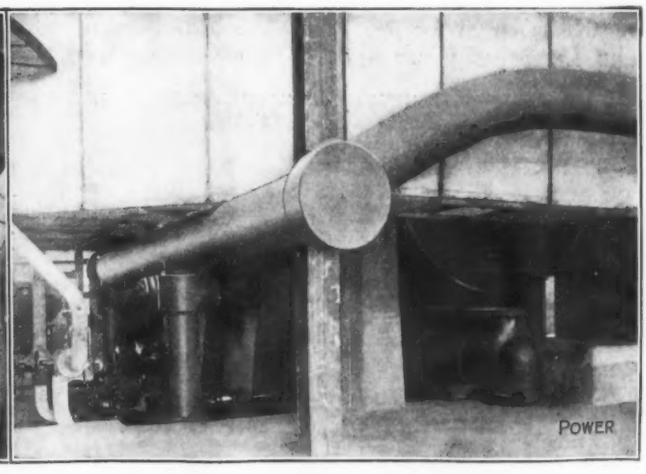


FIG. 5. ONE END OF THE LARGE JET CONDENSER AND THE PUMP TURBINES

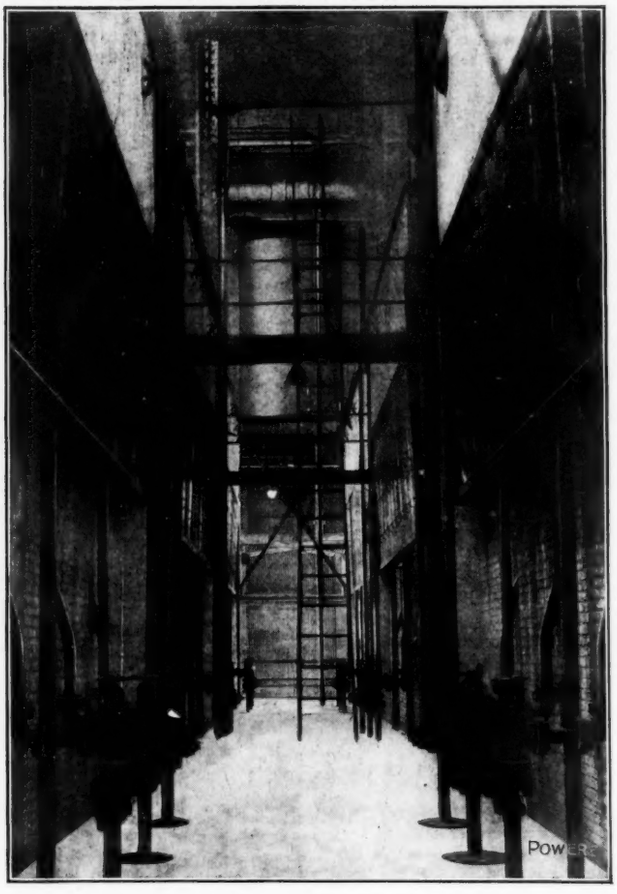


FIG. 7. VIEW AT REAR OF THE BOILERS

ment of water distribution and spray, combining the features of parallel-flow and counter-current types of jet condensers, makes it possible to effect close terminal differences between the vacuum temperature and the temperature of the discharge water at light and at full loads. Due to the arrangement of the air and removal pumps, it is possible to operate the condenser with but one set of pumps if at any time the turbine is carrying half-load.

BOILER HOUSE

The boiler room is laid out at right angles to the turbine room and contains at present six boilers each of 10,470 sq.ft. of heating surface, forming a unit designed to furnish steam for one 15,000-kw. turbo-generator or 1.43 kw. capacity per sq.ft. of boiler heating surface. Additional units of six boilers each will be added for each 15,000-kw. generator installed. The present stack serving the six boilers is of sufficient capacity to serve another unit of six.

Two walls of the boiler house are temporary, being made of asbestos-covered corrugated iron, which can be readily removed for extension. The asbestos color corresponds closely with the color of the concrete in the permanent building walls, and the general appearance of the structure is not marred by the temporary walls.

The boilers are set singly to allow access to both sides of the furnace, and they are supported from the building steel. The aisle between the rear ends of the two rows of boilers is unusually wide, giving ample space for operating blowoff valves and for repair work (Fig. 7). The space in front of the boilers is wide and well lighted, providing ample operating space for stokers, etc. (Fig. 8).

The building is provided with modern sanitary features consisting of a lavatory, toilets and shower baths. Ample light is admitted by numerous and large windows, rolled-steel sash and wire glass being used, with ventilating sections. A large storeroom is provided for in the basement, for repair materials and supplies.

BOILERS AND STOKERS

The water-tube boilers are three-pass, of the water-leg type, and are designed to operate at 200 lb. pressure. Each boiler is provided with a superheater of 1425 sq.ft. of heating surface, to give 100 deg. of superheat under all conditions of load. The ratio of superheater surface to the boiler heating surface is 1 to 7.34 sq.ft.

A balanced draft is maintained in the combustion chamber by means of apparatus which controls the flue damper of the boilers and also the forced-draft damper of the stoker, so that a constant draft or negative pressure is maintained. Each boiler has four blowoff valves and an 8-in. steam delivery pipe.

Each boiler is equipped with an 11-retort underfeed mechanical stoker with a grate area of 156 sq.ft., this being the area of the combustion chamber in a horizontal plane. This gives 67 sq.ft. of boiler heating surface to 1 sq.ft. of grate area. These stokers are guaranteed to maintain twice the boiler rating continuously or three times the boiler rating for a period of two hours. Forced draft is provided by four paddle-wheel blowers directly connected to horizontal engines; they deliver air at a maximum pressure equivalent to 6 in. of water.

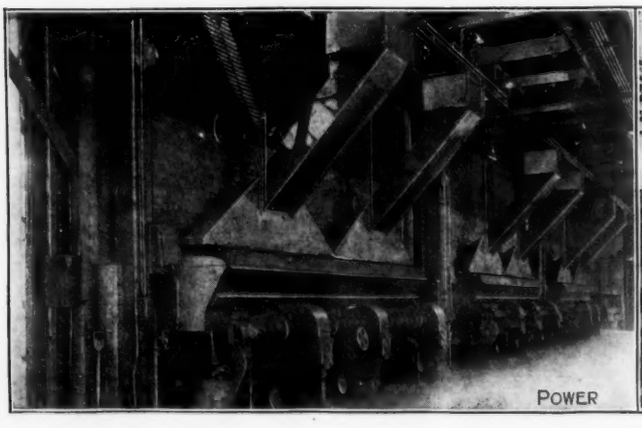


FIG. 8. STOKER SIDE OF THE BOILERS

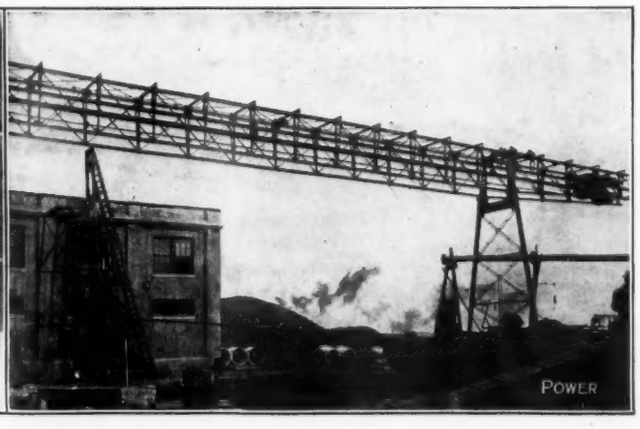


FIG. 9. TROLLEY BRIDGE AND GRAB BUCKET

The stack has an internal diameter of 20 ft. 3 in. and is built of radial brick. It is supported on six heavy steel columns and 72-in. girders, the base of the stack being 65 ft. above the foundation on which the steel is carried. The height of the stack is 215 ft. above the steel supports and 250 ft. above the boiler grates. The foundation for the stack is a monolith 35x40, 8 ft. deep, resting on 198 piles driven to an average depth of 25 ft. Grillages of steel beams are placed in this foundation, distributing the weight evenly from the columns to all of the piles. The weight of the stack is 1224 tons. The cross-section is 320 sq.ft. or 2.92 sq.ft. of grate area to 1 sq.ft. of stack area. When the additional six boilers are installed there will be 5.8 sq.ft. of grate area to 1 sq.ft. of stack area.

The steel breechings connect the flues at the tops of the boilers and extend in a straight line to the bottom of the stack, which they enter by making a quarter turn upward. The dimensions of the breeching are gradually increased by a tapering construction to give proper cross-section for the several boilers connected. The arrangement at the base of the stack gives minimum friction or interference of gases in entering.

The new boiler house is designed to receive coal by cable cars over a bridge from a high-speed coaling tower to be constructed on the bulkhead line. At present coal is transferred from the system supplying the boiler house serving the reciprocating engines.

The coal is brought to the plant in barges, from which it is lifted by a grab bucket and transferred by a trolley over a bridge into the old house (Fig. 9). Coal is deposited in a movable crusher which, after crushing, delivers it to the bunkers. From one of these bunkers it flows by gravity into a 2-ton skip hoist which lifts it to a hopper above the roof, from which it is discharged to a 3-ton electrically operated car. This car transfers coal over a bridge on the roof of the power house to the new boiler house and dumps it into hoppers. From these hoppers it is delivered into hand-push cars which distribute it to the bunkers above the new boilers. The bunker above three of the boilers has a capacity of 400 tons and that above the other three has a capacity of 600 tons to provide for an additional row of boilers to be installed in the future.

From these bunkers the coal passes to automatic weighing scales, two for each boiler. Each scale discharges into

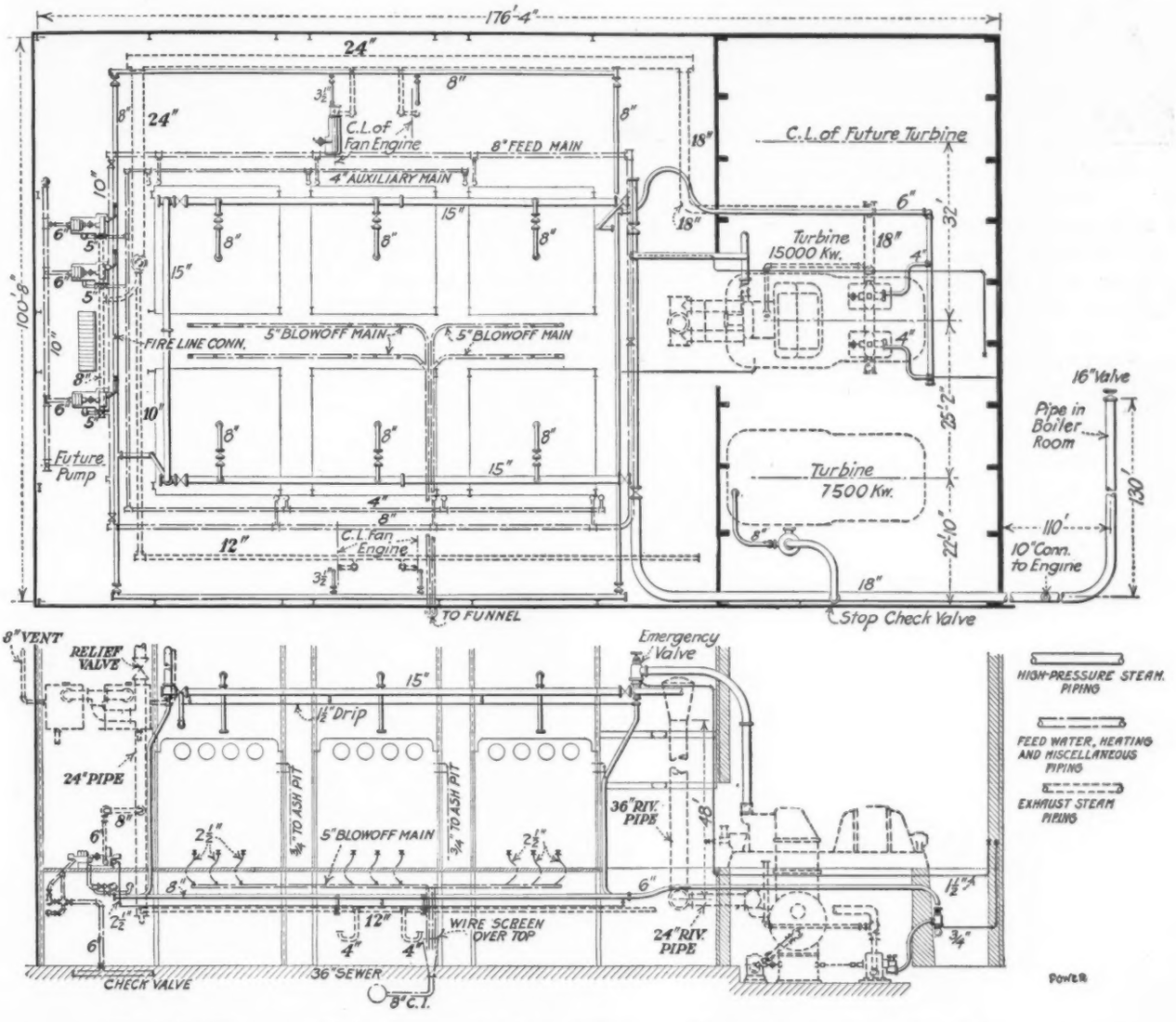


FIG. 10. PLAN AND ELEVATION OF THE MOST IMPORTANT PIPING IN THE NEW BOILER HOUSE

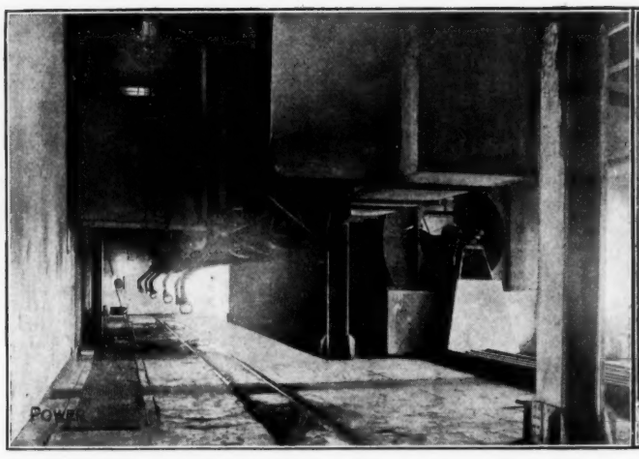


FIG. 11. ASH OUTLETS FROM ASH PITS

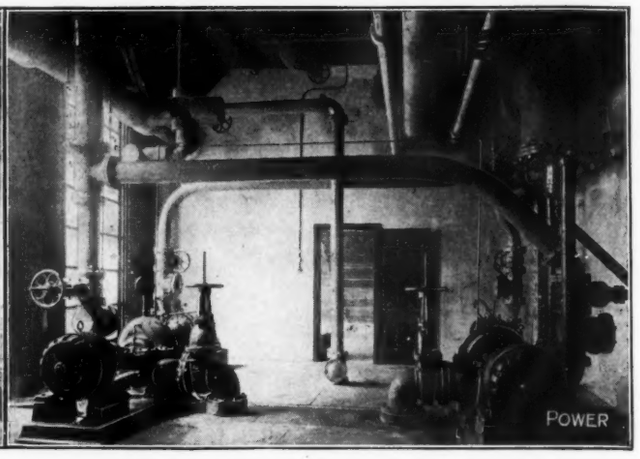


FIG. 12. SERVICE AND HEATER PUMPS

a chute equipped with a distributor which feeds the stoker hoppers, shown in Fig. 8.

Ashes from the stokers drop into ash hoppers in the basement. At the bottoms of these hoppers are 24x36-in. cast-iron gates. Ash cars run on tracks below these hoppers (Fig. 11) and are loaded by opening the gates mentioned. The ashes are used to reclaim land adjacent to the boiler house.

PIPING

Fig. 10 gives a plan and section of the more important piping in the new boiler house and turbine room. The main high-pressure piping in the boiler house consists of a loop of 15-in. pipe. Each of the boilers connects with this header through a long 8-in. bend. The 15,000-kw. turbine is served by a 14-in. connection. The new boiler house is connected with the old one by an 18-in. pipe line and the 7000-kw. turbine is supplied from this pipe, the arrangement of valves being such that steam can be taken from either the old or the new house.

The high-pressure steam for auxiliaries in the basement of the turbine and boiler rooms is supplied by another loop header located in the basement. This header receives steam from the main boiler-room header through either of two 8-in. connections and supplies the four blower engines in the basement. the steam-driven pumps and turbine auxiliaries.

Van Stone joints and welded nozzles were used on all high-pressure piping. Steel valves with monel-metal seats were used and 1914 drilling for all flanges. Remote-control valves are installed on the principal units and main connections so that some may be closed from a control point in emergency.

The exhaust piping is located in the basement, the connections from each of the auxiliaries leading to a main 24-in. exhaust line which rises to the two feed-water heaters. Just above the connection to the feed-water heaters a 24-in. relief valve is placed to force the steam through the heaters and to relieve the exhaust above a predetermined pressure.

All steam piping is covered with 85 per cent. magnesia of ample thickness to conserve heat, and the various classes are painted with colors that indicate their functions. The high-pressure steam piping is white, exhaust steam buff, fresh cold water blue, salt water green, and blowoff and drain connections black.

Two 10,000-hp. open heaters receive the exhaust steam and deliver the hot water to a V-notch recording meter and tank. An 8-in. vent with exhaust head is provided for each of the heaters, to pass air and excess steam.

All of the pumps for the new boiler house are located in the space under the stack on both the basement and the boiler-room floor levels, this location being central for present and future boilers.

Three boiler-feed pumps (Fig. 13) are provided, each of 500-gal. capacity per min. against 240 lb. per sq.in. They are driven by 110-hp. noncondensing, three-stage turbines at 2500 r.p.m., the pump having an efficiency of 65 per cent.

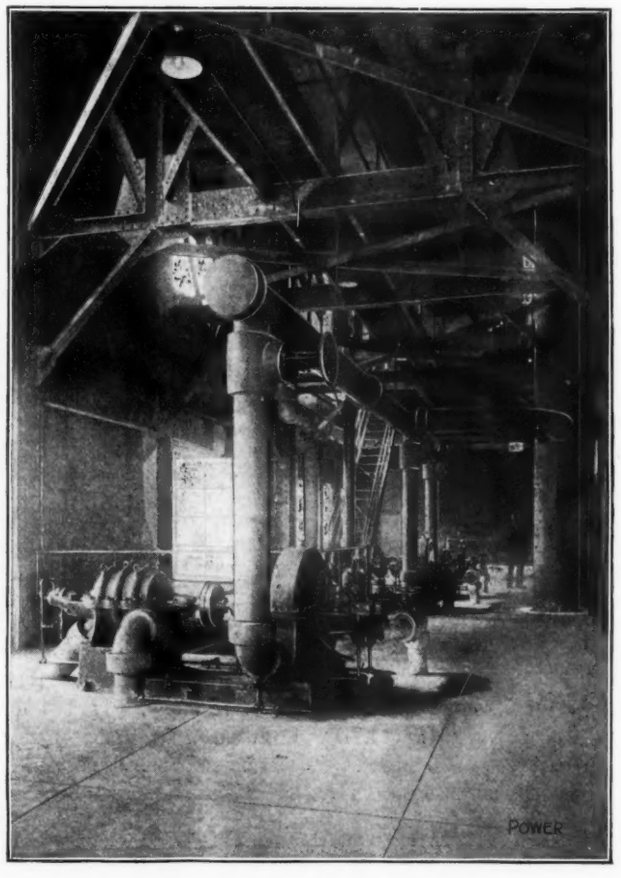


FIG. 13. BOILER-FEED PUMPS

PRINCIPAL EQUIPMENT OF THE NEW EXTENSION TO THE WESTPORT POWER PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
1	Turbine	Horizontal Curtis	7500-kw	Main unit	175 lb. steam, 100 deg. sup., 1500 r.p.m.	General Electric Co.
1	Turbine	Horizontal Curtis	15,000-kw	Main unit	175 lb. steam, 100 deg. sup., 1500 r.p.m.	General Electric Co.
2	Condensers	Jet	72,000 lb. steam per hr.	With 7500-kw. turbine	28½-in. vacuum	Alberger Pump & Condenser Co.
2	Engines	Fleming	12x14-in.	Driving circ. pumps	250 r.p.m.	Harrisburg Foundry & Machine Works
2	Pumps	Volute discharge	20-in.	With small condensers	Engine-driven	Alberger Pump & Condenser Co.
1	Condenser	Jet	25,000 gal. per min.	With 15,000-kw. turbine	28.5-in. vacuum	C. H. Wheeler Mfg. Co.
2	Turbines	Single-stage	300-hp	Driving condenser pumps	1050 r.p.m.	Terry Steam Turbine Co.
2	Pumps	Thissen	No. 20	With large jet condenser	1050 r.p.m.	C. H. Wheeler Mfg. Co.
6	Boilers	Edge Moor	10,470 sq.ft. heating surface	Steam generators	200 lb. steam, 100 deg. superheat	Edge Moor Iron Co.
6	Superheaters	Foster		With boilers	100 deg. superheat	Power Specialty Co.
6	Stokers	Taylor	8 ft., 3½ in. x 19 ft., 6 in.	Boiler furnaces	Automatic	American Engineering Co.
6	Meters	Steam-flow		On main boilers	Continuous	General Electric Co.
12	Scales	Automatic		Weighing hopper coal	Intermittent	Richardson Scale Co.
1	Crane	Gantry	7500-lb. capacity	Unloading coal	Motor-operated	Morgan Eng. Co.
4	Engines	Fleming	9½x12-in.	Driving Sirocco fans	Variable-speed	Harrisburg Foundry & Machine Works
4	Fans	Sirocco	9 ft. dia. wheels, 3 ft., 3½ in. wide	Forced draft	Engine-driven, variable-speed	American Blower Co,
6	Regulators	Draft-control		Air control to furnaces	Maintaining balanced draft	Blaisdell-Canady Co.
2	Pumps	Volute	2½-in.	Service	Motor-driven, 1420 r.p.m.	Alberger Pump & Condenser Co.
2	Motors	Induction	7½-hp.	Driving service pumps	440 volts, three-phase, 1420 r.p.m.	Westinghouse Electric & Mfg. Co.
2	Motors	Induction	20-hp.	Driving heater pumps	440 volts, three-phase, 1430 r.p.m.	Westinghouse Electric & Mfg. Co.
2	Pumps	Volute	8-in.	Supplying heaters	28-lb. head, 1430 r.p.m.	Alberger Pump & Condenser Co.
2	Heaters	Cochrane	300,000-gal. cap.	Feed water	Exhaust steam from aux. turbines	Harrison Safety Boiler Works
1	Meter	V-notch		Measuring feed water	Continuous	Harrison Safety Boiler Works
3	Pumps	Turbine	5-in.	Boiler feed	2400 r.p.m., turbine-driven	Alberger Pump & Condenser Co.
3	Turbines	Three-stage		Driving boiler-feed pumps	2400 r.p.m., 185-lb. steam	Alberger Pump & Condenser Co.
2	Pumps	Recip. 2-stage	24x24-in.	Dry vac. for 7500-kw. turbine	Engine-driven	Alberger Pump & Condenser Co.
2	Engines	Corliss, horizontal	8x24-in.	For dry vac. pumps	Variable-speed	Alberger Pump & Condenser Co.
2	Pumps	Injection volute	16-in.	7500 turbine condensers	Engine-driven	Alberger Pump & Condenser Co.

Two service pumps, each 150-gal. capacity per min. against a 90-ft. head, are driven by 7½-hp. induction motors at 1440 r.p.m. The efficiency of these pumps is 55 per cent.

These pumps supply water to two 25,000-gal. service tanks on the roof of the boiler house, one located on each side of the stack and supported by the same steel structure that carries the stack. This water is used for cooling and miscellaneous purposes.

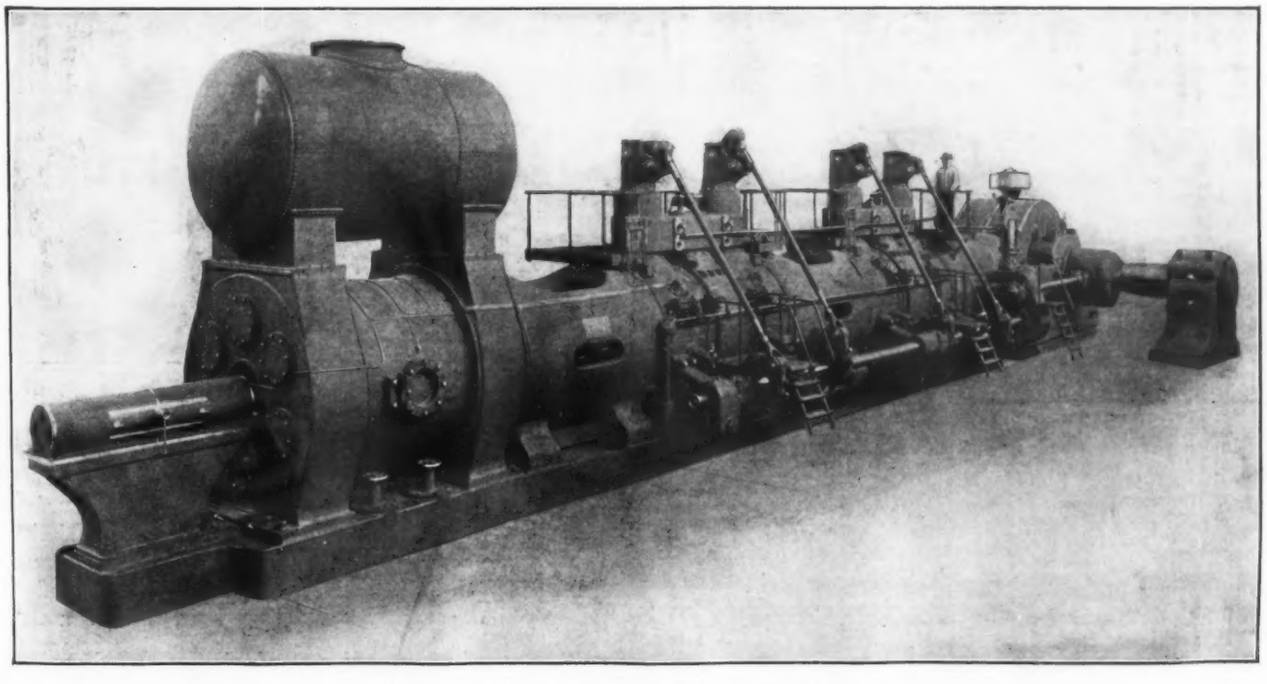
Two heater pumps, each of 1000-gal. per min. capacity against a 50-ft. head, are driven by 20-hp. induction motors. Each pump has an efficiency of 65 per cent.

Condensing water is supplied through a reinforced-concrete tunnel 10x12 ft. inside dimensions and the discharge water is carried away by another tunnel of the same construction and dimensions, under the basement floor, but located at a somewhat higher elevation. From the boiler room to the bulkhead line, a distance of 267 ft., the water is carried through two lines of reinforced-concrete pipe, 9 ft. inside diameter with a 9-in. wall. These pipes were molded in sections 15 ft. long, each section weighing 28 tons.

Large Blowing Engine

The photograph shows the largest single-tandem, gas blowing engine constructed to date in this country. It is one of two units built by the Mesta Machine Co. for the Pennsylvania Steel Co.'s plant at Steelton, Penn., and has gas cylinders 46 in. in diameter, air cylinders 84 in., and a stroke of 60 in. The speed will range from 45 to 85 r.p.m., depending upon the operating conditions.

The air end is equipped with automatic plate valves (Iversen patent) that require no valve-gear, which makes possible the placing of the air cylinder directly back of the gas cylinders, so that the air-cylinder piston can be driven directly through an extension of the gas-cylinder piston rod. The engine is of the center-crank type.



LARGEST SINGLE-TANDEM BLOWING ENGINE

Recent Development in the Construction of the Uniflow Engine

By Prof. J. Stumpf*

Since the first uniflow engine was erected in the shop of the Erste Bruenner Maschinenfabrik, engines aggregating more than 600,000 hp. have been put in operation. This figure proves better than words can do the value of the uniflow principle and the success is the more gratifying to the pioneer, because in the beginning he had to back the new idea against almost everybody.

Much credit must be given to the German licensees such as Gebruder Sulzer, Maschinenfabrik Augsburg-Nuernberg, Elsaessische Maschinenfabrik, Ehrhardt & Sehmer, Maschinenfabrik Esslingen, A. G. der Goerlitzer Maschinenfabrik and Maschinenfabrik Badenia, which last developed the uniflow locomobile engine. Professor Stumpf praises especially Sulzer Brothers, whose uniflow engines show the same high-grade design and workmanship as everything manufactured by this company. The largest engine which they have built is one of 2000 hp. installed in a cotton mill. Still larger engines have been made by Ehrhardt & Sehmer for driving rolling mills, among which are a 6000 and a 7000 hp., probably the largest output for single-cylinder engines ever made.

The standard Sulzer engines have no tail rod. It required much experimental work to find the mixture of cast iron suitable for piston and cylinder, and a large self-supporting piston needs careful lubrication to insure reliable operation. Other builders, like Ehrhardt & Sehmer, use tail rods with their big engines. Taking up the weight of the piston on a bearing surface outside of the cylinder facilitates lubrication, the bearing surface being small and having low temperature; the friction in the cylinder is reduced to that of the piston rings only, insuring long life of this part of the engine. Cylinders for big uniflow engines have to be bored in such a way as to make the bore uniform under working temperatures.

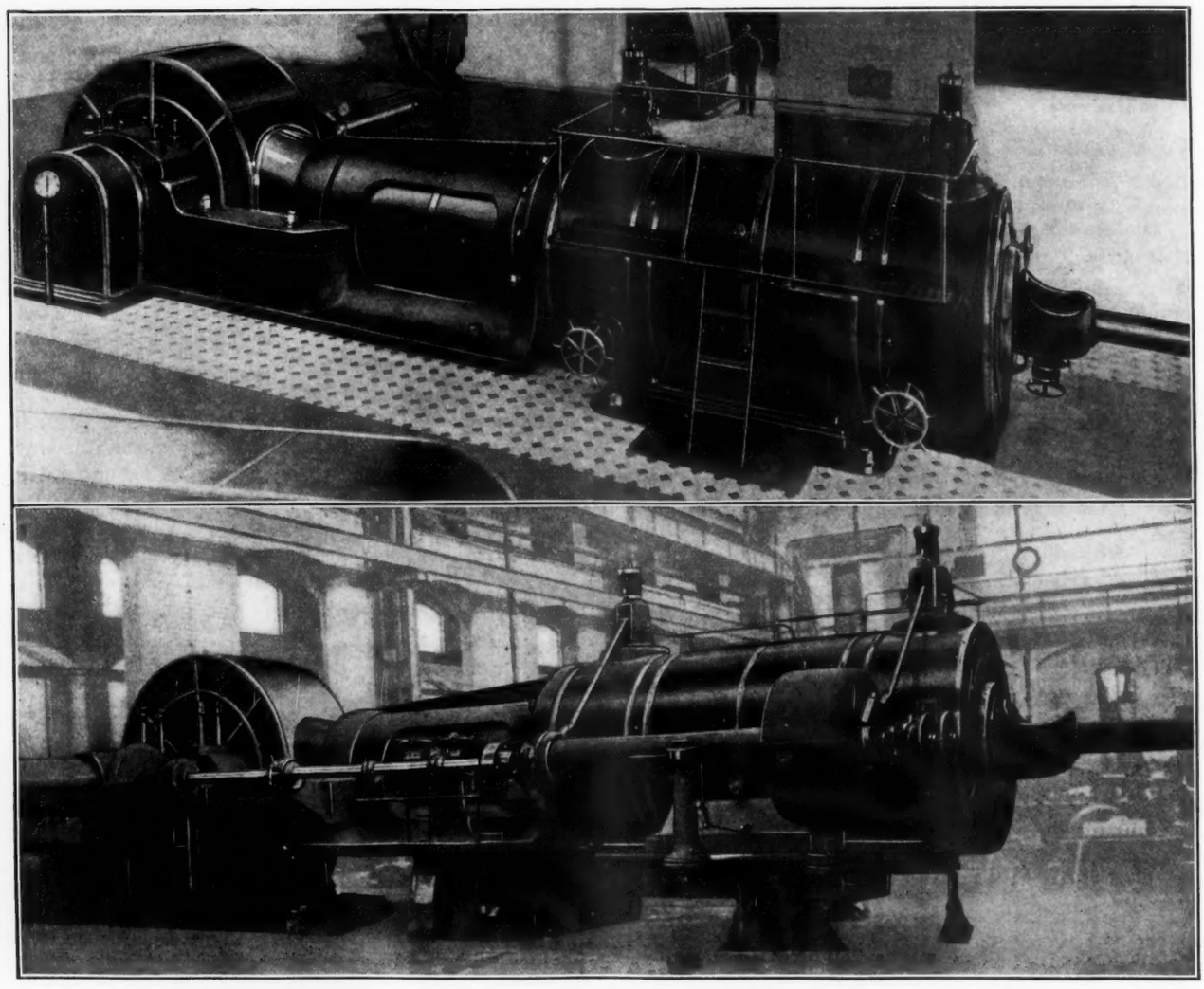


Fig. 1. Two Views of 2000-Hp. Sulzer Uniflow Engine for a Cotton Mill

In Fig. 1 are given two views of the 2000-hp. Sulzer

*Abstract by W. Turnwald of an article by Prof. Stumpf, published in the "Zeitschrift d. Vereines deutscher Ingenieure."

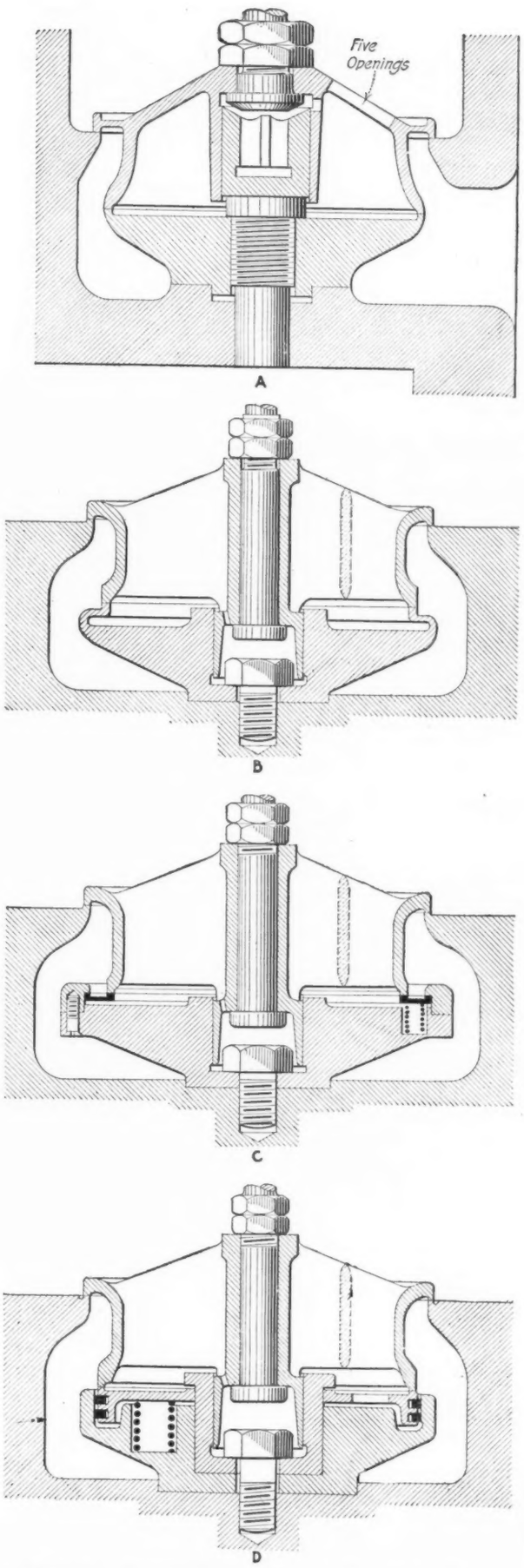


FIG. 2. POPPET VALVES WITH FLEXIBLE SEATS

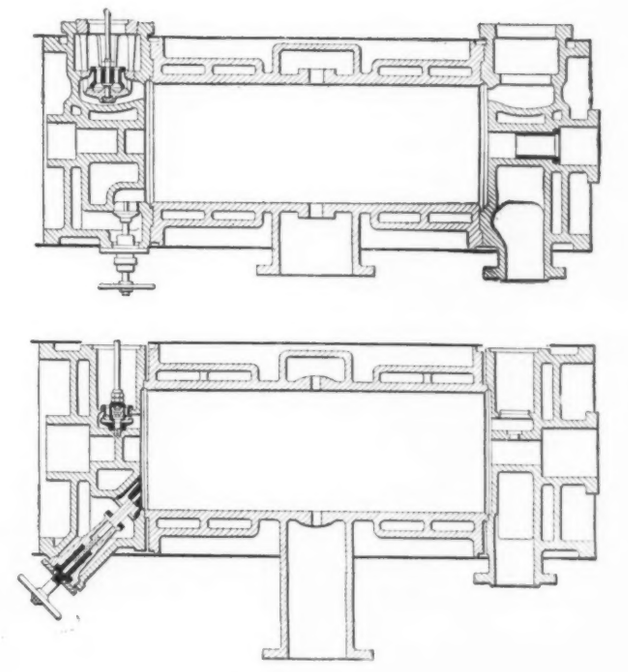


FIG. 3

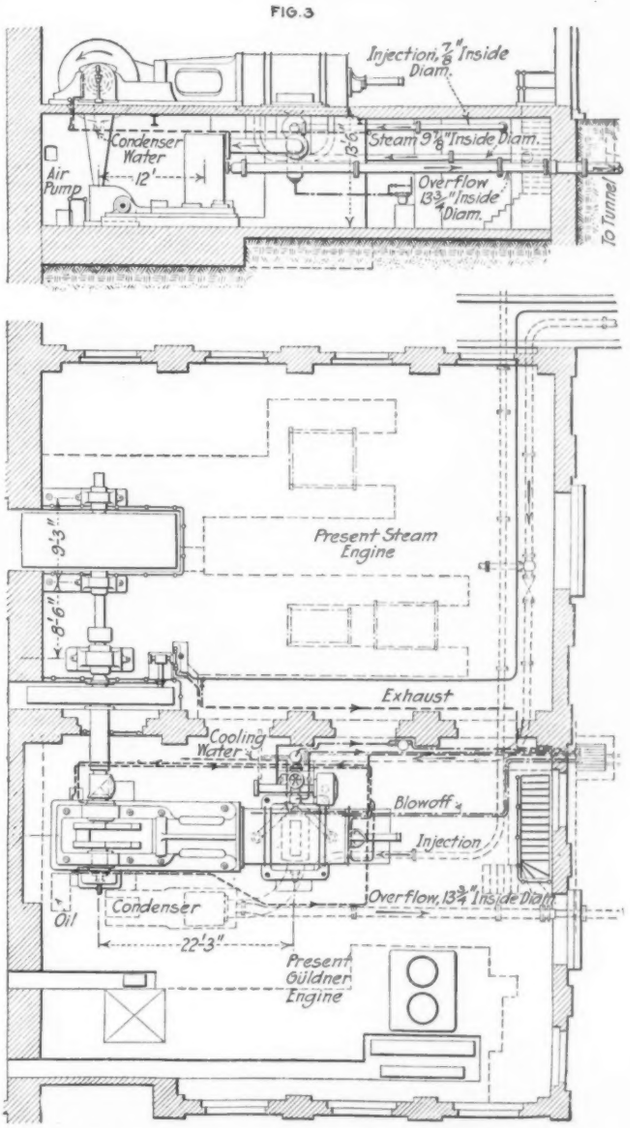


FIG. 4. PLAN AND ELEVATION OF 2000-HP. INSTALLATION

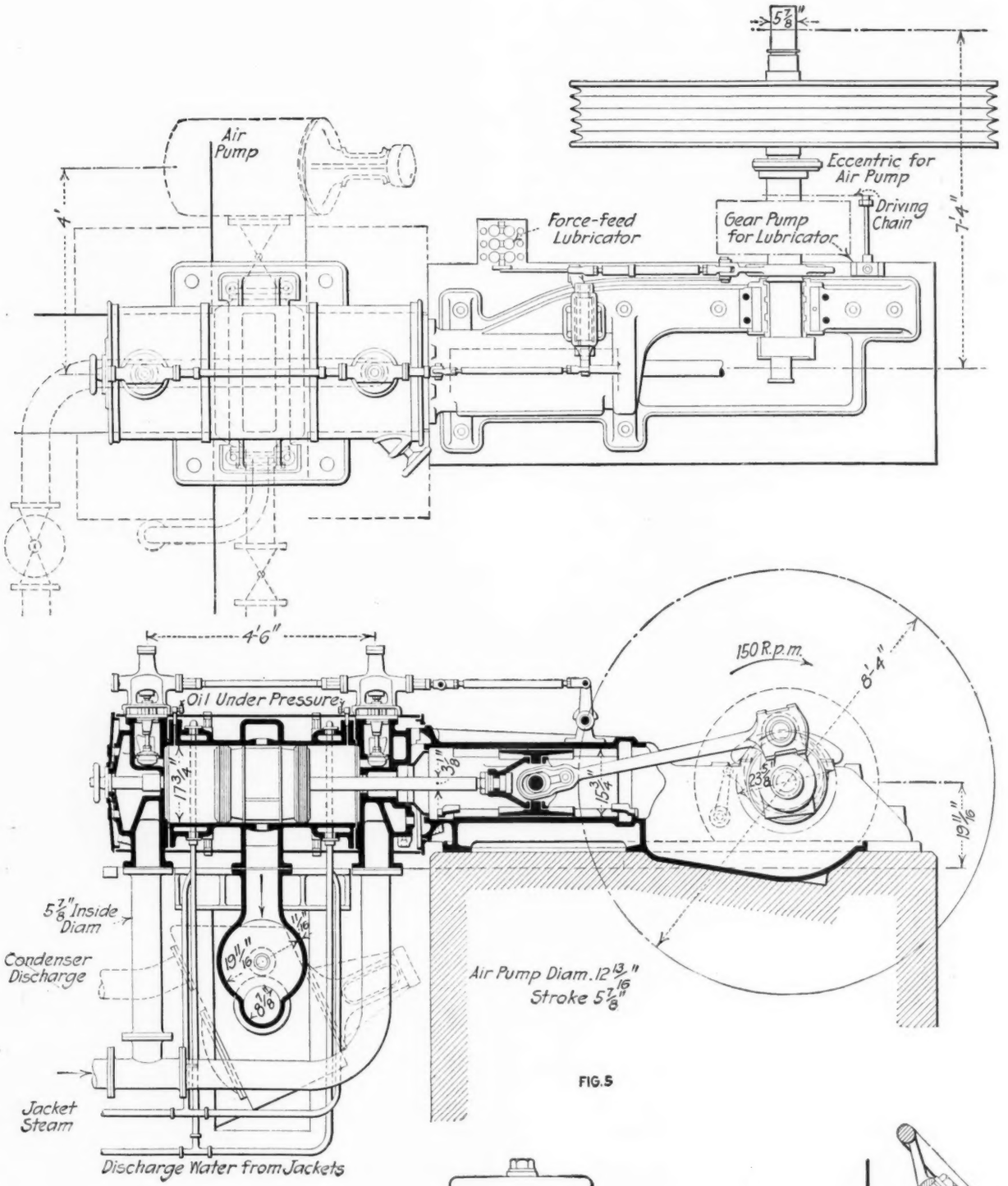


FIG. 5

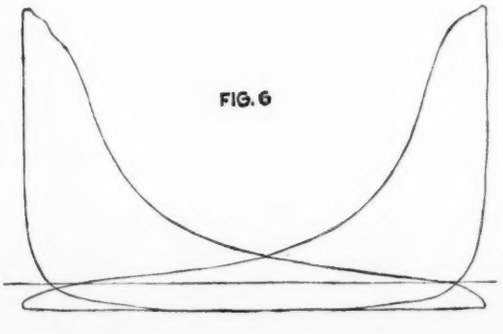
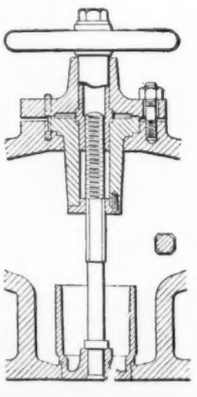


FIG. 6



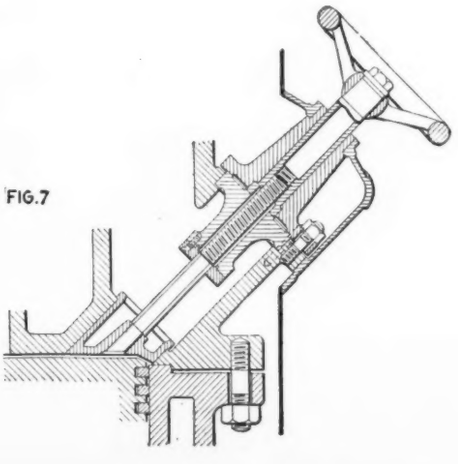


FIG. 7

engine; this engine having a tail rod only because the order called for it.

The driving parts, even those for driving the condenser air pump, are entirely inclosed. Forced-feed lubrication is used, the oil being supplied under a pressure of about 15 lb. by a small gear pump on the layshaft. The pump draws the oil from a reservoir in the basement and forces it into the main bearings, the discharge from the oil is collected in the crank pit and runs through a filter back to the reservoir to be used over and over again. Cylinder, stuffing-box and valve stems are lubricated from a separate oil pump, which is also driven by the layshaft; every feeder has its own plunger and the quantity of oil pumped is easily adjustable. The cylinder-oil consumption of a single-cylinder uniflow engine is of course considerably less than that of two- or three-cylinder compound engines.

All the larger engines are now built with layshaft and layshaft governor. The Sulzer engines have the governor close to the head-end bearing to prevent unnecessary deflection of the shaft. The governor acts by changing the stroke and the angle of advance of the eccentrics. Valve motions for uniflow engines have to be adjusted with small lead, and since the range of cutoff is short—only 25 per cent. maximum cutoff being required—it is

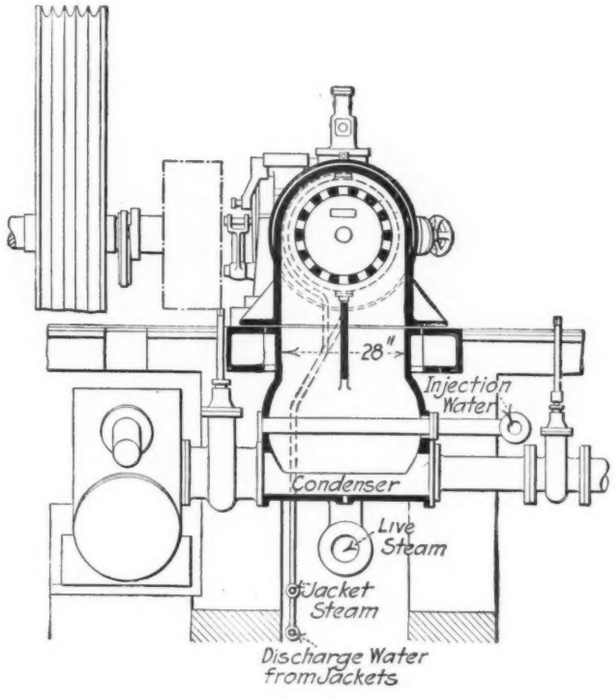


FIG. 8.

possible to keep the variation of the lead within one-half of one per cent. or less.

Double-beat poppet valves of the type used in compound engines have not proven successful with uniflow engines, where steam tightness of the valves is imperative. This can be insured only by making the valves as short as possible, by making one seat resilient and by balancing only to a certain amount, which has to be calculated. Fig. 2 shows valves of different types, suitable for uniflow engines. Such valves can be comparatively small. The cutoff is short and the gain in economy by reducing the clearance space outweighs the loss due to throttling. A good example of this is the cylinder of a pumping engine shown in Fig. 3, in which the clearance was reduced from 4 to 1.3 per cent. by using smaller valves, resulting in a reduction in steam consumption of more than one pound per horsepower-hour.

The elevation and plan of the 2000-hp. Sulzer engine as installed are shown in Fig. 4. All the piping is beneath the floor level, the steam pipe at one side of the engine, the exhaust pipe and air pump at the other. The condenser is connected to the exhaust belt through a wide opening so the pressure can equalize immediately.

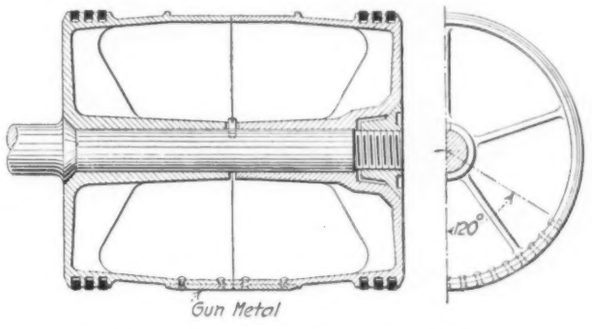


FIG. 9. PISTON OF UNIFLOW ENGINE

The air pump is driven from the main shaft by means of a crank and bell crank.

Belts are used for transmission, one for every story of the factory. The governing of the engine fulfills all the requirements of spinning machinery, with a comparatively light flywheel, because the governor of a uniflow engine controls more directly than in the compound engine where the influence of the governor is limited to the high-pressure cylinder. The steam consumption of this engine is better than that of a triple-expansion of the same size. Indicator diagrams are shown in Fig. 6; noteworthy is the shape of the compression line, which is almost adiabatic.

An 18x24-in., 150-r.p.m. side-crank engine, designed some time ago, is shown in Figs. 5 and 8. Cylinder and cylinder heads are jacketed, the steam for the cylinder jackets being taken from the steam main before the stop valve so the engine may be warmed up before starting it.

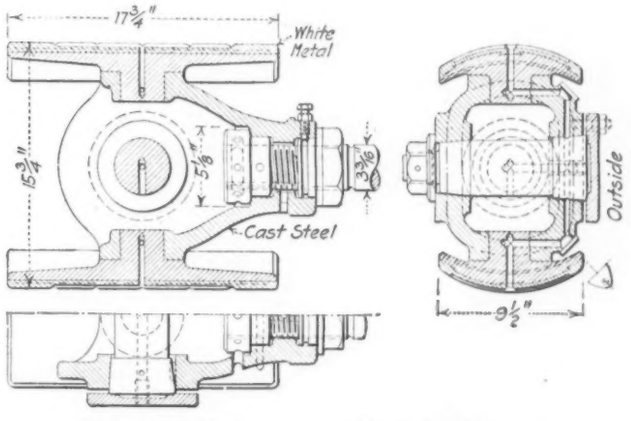


FIG. 10. CROSSHEAD OF UNIFLOW ENGINE

The condenser is placed close to the cylinder and is used as a muffler in case the engine is operating noncondensing. The air pump is driven from the engine shaft by an eccentric. The pump has no suction valves and very low clearance. The steam valve is of the resilient type shown at *A* in Fig. 2. Bypass valves for the additional clearance space, Fig. 7, are of a new type to give

the smallest clearance when operating condensing. For relief valves the steam valves are relied on. The clearance space of this engine does not exceed 1.25 per cent. when operating condensing. The piston, Fig. 9, which is extremely light, is made in two parts of cast steel, fitted with three rings at each end. No tail rod is used, but the piston has a brass-mounted bearing surface in the middle and covering one-third of the circumference. The piston itself has ample clearance all around. The details of the crosshead are shown in Fig. 10.

It is wrong in principle to build uniflow engines for condensing service with auxiliary exhaust valves. The short compression is wrong and just as wrong is the increase of clearance space and surface connected with these valves. Even for noncondensing service, with steam pressures as used in modern power plants, auxiliary exhaust valves show no gain.

Professor Naegel, of the Technische Hochschule, Dresden, who conducted elaborate temperature measurements on a uniflow cylinder, says in his report: " . . . The uniflow engine of the Stumpf type is able to utilize the steam in single-stage expansion in a more perfect way than it was possible to do before with the best multiple-expansion engines. The reason for this is the elimination of the initial condensation and the reduction of heat transmission through the walls, accomplished by the particular flow of steam through head jacket, steam valve, cylinder and exhaust ports, which constitutes the "Unaflow Principle."

Bayer Feed-Water Purifier

The effect of scale on the operating efficiency of a boiler and the difficulty and cost of its removal are factors which have led to the design of various types of apparatus for removing the suspended matter and scale-forming ingredients before the water enters the boiler. It will be generally conceded that this is the proper method to follow and that the solution of the problem rests in securing a device that will do the work efficiently and at a low cost. Quite recently, the Bayer Steam Soot Blower Co., of St. Louis, has given some attention to this question and is putting on the market the purifier illustrated herewith. It is licensed under Ray patents and is made for return-tubular and the various types of water-tube boilers.

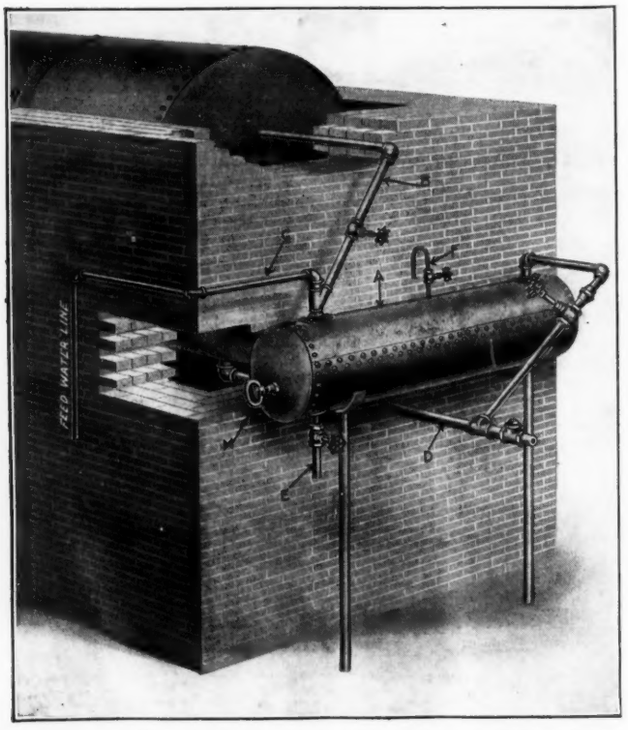


Fig. 1. Bayer Purifier Attached to Return-Tubular Boiler

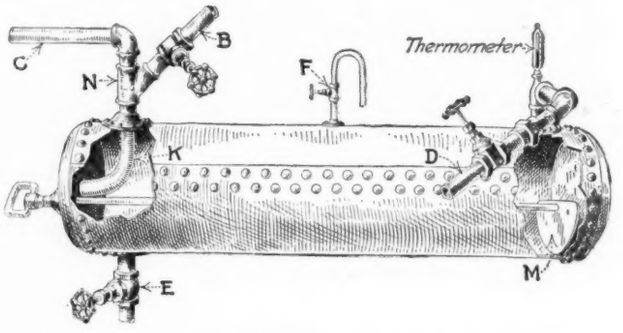


Fig. 2. Separating Tank in Part Section

Fig. 1 shows the purifier applied to a return-tubular boiler and Fig. 2 shows the tank in part section. The device consists of a cylindrical tank varying in size from 16x60 in. for a 100-hp. boiler to 33x144 in., the larger boilers being of the water-tube type. When the boiler is in operation a circulation of hot water is set up through the connecting piping and the tank. Any sludge remains in the tank and may be blown out through pipe *E*, while

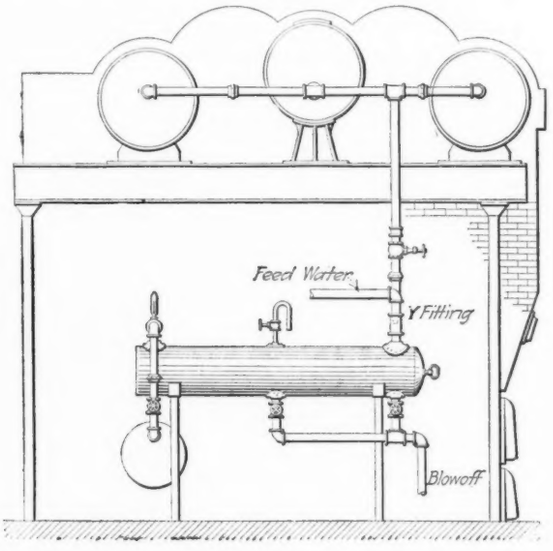


Fig. 3. Stirling Boiler Served by Purifier

the water is forced through an outlet at the top of the tank and returned to the boiler through the blowoff pipe *D*. There are three forces which tend to produce circulation through the system. The internal circulation in the boiler forces the water to the rear end, and it is at this point that pipe *B* enters the boiler just below the water level. The difference in weight of the water columns within and exterior to the boiler also tends to produce circulation, and this is augmented by the action of the ejector nozzle *N* and pressure from the boiler-feed pump. Water thus comes from the boiler at a temperature corresponding to the pressure, mixes with the feed at the Y

fitting *N* and discharges against the head of the tank through the elbow *K* to obtain a uniform flow through the tank. The latter is made large enough so that the velocity of the water will be relatively slow, giving time for the foreign matter heavier than water to be deposited on the bottom of the tank. The purified water then returns through pipe *D* to the boiler. By properly proportioning the sizes of pipes *B* and *C*, the water in the tank can be maintained at a temperature but little lower than that in the boiler. The tank will therefore separate the suspended matter and scale-forming ingredients affected by temperature. If it is necessary to treat the water, the reagent should be mixed with the feed water before it enters the tank, so that the impurities will be precipitated in the purifier instead of in the boiler.

Scraper *M* has been provided to pull the deposited matter toward the blowoff at the opposite end of the tank. Valve *F* allows air to escape when first filling the tank and may also be used for drawing off samples of water for testing purposes.

On other types of boiler the operation is substantially the same. The pipe discharging to the tank is always tapped to that portion of the boiler just below the water line, toward which the water on the surface flows. The return pipe is connected to the water leg, mud drum or boiler blowoff, depending on the type of boiler. Fig. 3 shows the purifier connected to a Stirling boiler.

Examination Questions

Two sets of examination questions written from memory after the test was over:

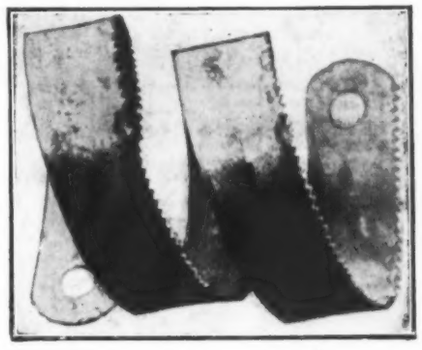
1. How would you determine the highest safe working pressure on a boiler of the horizontal type?
2. How would you determine the area of safety valve—first, lever valve; second, pop valve—required on a horizontal tubular boiler?
3. How could you determine at what pressure a lever valve was set to blow off, also a pop valve?
4. How would you figure out the number of braces required to properly support flat surfaces above the tubes in a boiler of the horizontal type?
5. Give the dimensions for riveted joints single and double, also the sizes of rivets required for the following thicknesses of metal: $\frac{5}{16}$ in.; $\frac{7}{8}$ in.; $\frac{3}{8}$ in. Give pitch of stay-bolts, also size for bracing the following area: 20x32 three-eighth-inch plate to sustain 120 lb. pressure.
6. Determine the capacity of a pump or injector necessary to supply a boiler rated at 100 hp. with sufficient water, the calculation to be based on the assumption that 30 lb. of water is evaporated per horsepower per hour.
7. Give your ideas for the proper connections of water column and steam gage to boilers. Make a sketch of same.
8. What is the best way to set two 60-in. boilers? Give thickness of walls, spaces and such dimensions as are necessary for the execution of the work. Describe the principle of fuel combustion, the effects of sulphur in fuel, the necessary elements and conditions for best results.
9. Describe what you would do in making an internal examination of a horizontal tubular boiler.
10. Describe what you would do in making an external examination of a boiler.
11. Give the names of the different types of boilers you are familiar with and how classified.
12. Give the names of the principal types of boilers in common use.
13. State what experience you have had in boiler construction, repairing or operation.
14. What in your opinion is the cause of leaky tubes?
15. How would you determine the point of leakage from an internal view of boiler, and how would you determine if inside plate was cracked or rivet broken from viewing the external part of boiler where the leakage was?
16. What, in your opinion, is the cause of boiler explosions?
17. What means would you suggest to minimize the hazard?

1. Draw a diagram showing the admission valves of a Corliss leaking and one of the exhaust valves leaking.
2. What is the effect on a cross-compound if the valves of the high-pressure sides are leaking?
3. If the receiver pressure is too high what effect has it? What would you do to equalize the work done in both engines?
4. How would you change the speed of the Corliss engine?
5. Draw a diagram of a high-speed engine, showing the valve leaking.
6. Which would you prefer—a simple slide-valve engine or an automatic cutoff, both having the same-sized cylinders and to run at the same speed doing the same work, and why? Is there any difference in horsepower?
7. Where is the steam cut off in a pump and can the valve motion be made to cut off in an ordinary steam pump any earlier in the stroke.
8. On a triple-expansion engine draw a diagram showing the intermediate admission valves and exhaust valve leaking.
9. What effect will it have on the low-pressure cylinder, if the admission valves are leaking?
10. In a Corliss engine, what determines the point of cutoff and how?
11. In an automatic cutoff engine what determines the point of cutoff and how?
12. If you want to change a Corliss engine with a single eccentric from noncondensing to condensing, what would you do; and with a double-eccentric engine what would you do?

Nonbreakable Hacksaw Blade

The chief claim for this hacksaw blade, as will readily be appreciated from the illustration, is its flexibility.

The blade shown, twisted into a coil one inch in diameter, was subsequently straightened out and run for the full life of the saw teeth.



NONBREAKABLE HACKSAW BLADES

This type of nonbreakable blade is the latest addition to the line made by E. C. Atkins & Co., Indianapolis, Ind.—*American Machinist.*

A Correction—Hubert E. Collins writes that he was in error in stating in his article on an "Interesting Steam-Pipe Installation," on page 288, issue of Mar. 2, that the main which he describes was covered with 85 per cent. magnesia. The covering used was the Nonpareil High-Pressure type, manufactured by the Armstrong Cork & Insulation Co., Inc.

Some Common Misconceptions—A mass of aluminum weighs one pound; a mass of lead of equal size weighs something more than four pounds. Some will thoughtlessly say that aluminum is more than four times lighter than lead. Weight (heaviness) is an attribute of matter; lightness is absence, or deficiency of weight. To say that one article is a certain number of times lighter than another is like saying of two vessels that one is four times emptier than the other.

It might be added that it is equally erroneous to say that one body or substance is colder than another. There is no such thing as cold; there are only varying degrees of heat, although we commonly regard as cold those things that are below 98 deg. F., or below the temperature of the human body. A substance that is at the freezing temperature is quite hot compared with liquid air, as the latter boils violently when placed upon a cake of ice. Temperatures that are fatal to life are far below those used in metallurgical processes.

Properties of Saturated Air

By W. D. Ennis

SYNOPSIS—An explanation is given of underlying principles and method of computing a table of Properties of Air Saturated with Moisture, together with examples of applications of the table.

Most engineers are familiar with the steam table, or table of properties of saturated steam, but not as many of them are as well acquainted with the properties of saturated air. The table presented herewith is the result of computations made by senior students (of the class of 1915) in mechanical engineering at the Polytechnic Institute of Brooklyn: T. B. J. Merkt, Samuel Blakeman, George Wieber, Walter L. Betts, S. Ishimura, R. B. Fuller, Murray Harris, John DeGroot, Harvey Sand, Van Wyck Hewlett.

Before showing some of the uses of the table, the method of computing it will be explained. To begin with, the word "saturated," as applied to a mixture of air and water vapor, has a different meaning from that understood when we speak of "saturated" steam. When dry air and moisture are brought together at any temperature, the moisture vaporizes until the vapor pressure is that "corresponding" with the temperature, i.e., that pressure which, according to the steam table, is the pressure of saturated steam at the given temperature. The mixture is then called saturated air, and the water vapor in the mixture is saturated steam. If, however, the supply of water is insufficient, its pressure, after it is all vaporized, will be less than that which the steam tables give, and the vapor, or steam, will be superheated.

From the Marks and Davis steam tables, at 40 deg. F. the pressure of saturated steam is 0.1217 lb. per sq.in., and its density, or weight per cubic foot, is 0.000410 lb. With these data, we proceed to compute the properties of 1 cu.ft. of saturated air.

According to Dalton's law, in a mixture of two or more gases, the total pressure is the sum of the partial pressures of the constituents, and each partial pressure is that pressure which the gas in question would exert if it alone occupied the total space. If our mixture is 1 cu.ft. at standard atmospheric pressure (14.697 lb. per sq.in.) and 40 deg., the partial pressure of the air is 14.697 — 0.1217 = 14.5753 lb. per sq.in.

The weight of air in the mixture is computed from the formula:

$$W = \frac{144\,P}{R\,(T + 460)} = \frac{2.6986\,P}{T + 460}$$

where

W = Weight of dry air in 1 cu.ft. of mixture, lb.;
P = Partial pressure of air, lb. per sq.in.;
$R = 53.36$;
T = Temperature Fahrenheit.

The total weight of 1 cu.ft. of the saturated mixture is then

Weight of dry air + weight of steam, or

$$\frac{2.6986 \times 14.5753}{40 + 460} + 0.00041, =$$

$$0.0787 + 0.00041 = 0.07911 \text{ lb.}$$

(Note: 1 cu.ft. of dry air unmixed with moisture, at atmospheric pressure and 40 deg. F., would have weighed $\frac{2.6986 \times 14.697}{40 + 460} = 0.0794$ lb.)

The wetness, or absolute humidity, of the saturated air is defined as

Weight of steam ÷ weight of air, or

$$0.00041 \div 0.0787, = 0.00521.$$

The table shows that as the temperature increases, the steam pressure and weight of steam increase, while the weight of dry air and its pressure decrease. When a temperature of 212 deg. is reached, the mixture is *all steam,* the air pressure and weight are both zero, and the humidity has the greatest possible value. At all temperatures the mixture weighs less than the same volume of dry air would weigh at standard atmospheric pressure.

Unsaturated air contains less than the maximum proportion of steam for the existing temperature. The steam (consequently superheated) exerts a pressure p' less than the saturated pressure p. Its density, or weight per cubic foot, w' is similarly less than the saturation density w. What is called *relative humidity* is defined as

$$r = \frac{p'}{p} = \frac{w'}{w}$$

Using primes to denote unsaturated conditions,

$$P' = 14.697 - p'; \quad w' = w\frac{p'}{p}; \quad W' = W\frac{P'}{P}$$

and the absolute humidity of the unsaturated air is

$$r' = \frac{w'}{W'}$$

Some Applications

General Gas Equation—One of the commonest formulas in heat and power calculations is that relating to the volume, pressure and temperature of a gas:

$$W = \frac{1}{V} = \frac{144\,P}{R\,(T + 460)}$$

as already stated (V = volume of 1 lb. of gas in cu.ft.). For dry air, $R = 53.36$, but in nearly all engineering applications we deal not with dry, but with moist air. The value of R for such air is not 53.36, but $\frac{85.8\,w' + 53.36\,W'}{w' + W'}$.

As an illustration, consider a mixture at 200 deg. F., having a relative humidity of 0.90. At this temperature, the saturated steam pressure is $p = 11.52$. The partial pressure of the superheated steam in this unsaturated mixture is then by definition,

$p' = r \times p = 0.90 \times 11.52 = 10.368$ *lb. per sq.in.*

The weight of 1 cu.ft. of saturated steam at 200 deg. is

$w = 0.02976$ *lb.*

The weight of steam in the unsaturated mixture is

$w' = rw = 0.90 \times 0.02976 = 0.026784$ *lb.*

The partial pressure of dry air in the unsaturated mixture is

$P' = 14.697 - p' = 14.697 - 10.368 = 4.329$ *lb. per sq.in.*

The weight of the dry air is then

$$W' = W\frac{P'}{p} = 0.0130 \times \frac{4.329}{3.177} = 0.0178 \text{ lb.}$$

Properties of Air Saturated with Moisture

At Normal Atmospheric Pressure P_B = 14.697 lb.

Note: P_B varies about ½ lb. per 1000 ft. of altitude. 7000 grains = 1 lb.

Column T = Temperature Fahrenheit.

Column A = Weight of 1 cu.ft. of dry air, lb., = 2.6986 $P_B \div (T + 460)$.

Column p = Steam pressure, lb. per sq.in., from steam table. Note: This is the maximum pressure that the steam can exert at the temperature T, so that the steam is saturated.

Column P = Dry air pressure, lb. per sq.in., = $P_B - p$.

Column w = Weight of steam in 1 cu.ft. of mixture (tabular density), lb. This is the maximum weight of steam that 1 cu.ft. of mixture can contain at the temperature T.

Column W = Weight of air in 1 cu.ft. of mixture, lb., = 2.6986P ÷ (T + 460).

Column $\frac{w}{W}$ = Lb. of steam mixed with 1 lb. of dry air, or absolute humidity.

Column w + W = Weight of 1 cu.ft. of mixture, lb.

T	A	p	P	w	W	$\frac{w}{W}$	w + W
32	0.0807	0.0886	14.608	0.000304	0.0802	0.00379	0.0805
33	0.0805	0.0922	14.605	0.000316	0.0801	0.00394	0.0804
34	0.0804	0.0960	14.601	0.000328	0.0798	0.00411	0.0802
35	0.0802	0.0999	14.597	0.000340	0.0797	0.00427	0.0800
36	0.0800	0.1040	14.593	0.000353	0.0795	0.00444	0.0798
37	0.0799	0.1081	14.589	0.000367	0.0793	0.00463	0.0796
38	0.0797	0.1125	14.585	0.000381	0.0791	0.00480	0.0795
39	0.0795	0.1170	14.580	0.000395	0.0789	0.00501	0.0793
40	0.0794	0.1217	14.575	0.000410	0.0787	0.00521	0.0791
41	0.0792	0.1265	14.570	0.000425	0.0785	0.00550	0.0789
42	0.0791	0.1315	14.566	0.000441	0.0784	0.00563	0.0788
43	0.0789	0.1366	14.560	0.000458	0.0782	0.00586	0.0786
44	0.0788	0.1420	14.555	0.000475	0.0780	0.00609	0.0785
45	0.0786	0.1475	14.550	0.000492	0.0778	0.00632	0.0783
46	0.0784	0.1532	14.544	0.000510	0.0776	0.00657	0.0781
47	0.0783	0.1591	14.538	0.000529	0.0775	0.00683	0.0780
48	0.0781	0.1651	14.532	0.000548	0.0773	0.00709	0.0778
49	0.0780	0.1715	14.522	0.000567	0.0771	0.00736	0.0776
50	0.0778	0.1780	14.519	0.000587	0.0769	0.00763	0.0775
51	0.0777	0.1848	14.512	0.000608	0.0767	0.00793	0.0773
52	0.0775	0.1917	14.505	0.000630	0.0765	0.00823	0.0772
53	0.0774	0.1989	14.498	0.000653	0.0763	0.00855	0.0770
54	0.0772	0.2063	14.491	0.000676	0.0761	0.00888	0.0768
55	0.0771	0.2140	14.483	0.000700	0.0760	0.00922	0.0767
56	0.0769	0.2219	14.475	0.000724	0.0758	0.00956	0.0765
57	0.0768	0.2301	14.467	0.000749	0.0756	0.00991	0.0763
58	0.0766	0.2385	14.459	0.000775	0.0754	0.01028	0.0762
59	0.0764	0.2472	14.450	0.000801	0.0752	0.01064	0.0760
60	0.0763	0.2562	14.441	0.000828	0.0750	0.01104	0.0758
61	0.0762	0.2654	14.432	0.000856	0.0748	0.01144	0.0756
62	0.0760	0.2749	14.422	0.000885	0.0746	0.01186	0.0755
63	0.0759	0.2847	14.412	0.000915	0.0744	0.01221	0.0753
64	0.0757	0.2949	14.402	0.000946	0.0742	0.01274	0.0752
65	0.0756	0.3054	14.592	0.000977	0.0740	0.01320	0.0750
66	0.0755	0.3161	14.381	0.001009	0.0738	0.01380	0.0748
67	0.0753	0.3272	14.370	0.001043	0.0736	0.01416	0.0747
68	0.0752	0.3386	14.358	0.001077	0.0734	0.01467	0.0745
69	0.0750	0.3504	14.347	0.001112	0.0733	0.01518	0.0744
70	0.0749	0.3626	14.334	0.001148	0.0730	0.01572	0.0742
71	0.0748	0.3751	14.322	0.001186	0.0728	0.01626	0.0740
72	0.0746	0.3880	14.309	0.001224	0.0726	0.01685	0.0739
73	0.0745	0.4012	14.296	0.001263	0.0724	0.01744	0.0737
74	0.0743	0.4148	14.282	0.001304	0.0722	0.01805	0.0735
75	0.0742	0.4288	14.286	0.001346	0.0720	0.01869	0.0734
76	0.0741	0.4432	14.254	0.001389	0.0718	0.01934	0.0732
77	0.0739	0.4581	14.239	0.001433	0.0716	0.02001	0.0730
78	0.0738	0.4725	14.224	0.001477	0.0714	0.02069	0.0729
79	0.0736	0.4893	14.2077	0.001523	0.0712	0.02139	0.0727
80	0.0735	0.505	14.192	0.001570	0.0710	0.02222	0.0726
81	0.0734	0.522	14.175	0.001619	0.0708	0.02288	0.0724
82	0.0732	0.539	14.158	0.001670	0.0705	0.02367	0.0722
83	0.0731	0.557	14.140	0.001723	0.0703	0.02447	0.0721
84	0.0730	0.575	14.132	0.001777	0.0701	0.02535	0.0720
85	0.0728	0.594	14.103	0.001832	0.0699	0.02621	0.0717
86	0.0727	0.613	14.084	0.001889	0.0697	0.02712	0.0715
87	0.0726	0.633	14.064	0.001947	0.0694	0.02804	0.0714
88	0.0724	0.654	14.043	0.002007	0.0692	0.02900	0.0712
89	0.0723	0.675	14.022	0.002068	0.0690	0.02998	0.0710
90	0.0722	0.696	14.001	0.002131	0.0688	0.03100	0.0709
91	0.0720	0.718	13.979	0.002195	0.0685	0.03204	0.0707
92	0.0719	0.714	13.956	0.002261	0.0683	0.03312	0.0705
93	0.0718	0.765	13.932	0.002329	0.0680	0.03423	0.0704
94	0.0716	0.789	13.908	0.002398	0.0678	0.03537	0.0702
95	0.0715	0.813	13.884	0.002469	0.0676	0.03655	0.0700
96	0.0714	0.838	13.859	0.002542	0.0673	0.03776	0.0699
97	0.0712	0.864	13.833	0.002617	0.0671	0.03902	0.0697
98	0.0711	0.891	13.806	0.002693	0.0668	0.04030	0.0695
99	0.0710	0.918	13.779	0.002771	0.0666	0.04163	0.0693
100	0.0709	0.946	13.751	0.002851	0.0663	0.04300	0.0692
101	0.0707	0.975	13.722	0.002933	0.0660	0.04440	0.0690
102	0.0706	1.005	13.692	0.003017	0.0658	0.04586	0.0688
103	0.0705	1.035	13.662	0.003104	0.0655	0.04736	0.0686
104	0.0704	1.066	13.631	0.003192	0.0653	0.04891	0.0684
105	0.0702	1.098	13.599	0.003282	0.0650	0.05049	0.0683
106	0.0701	1.131	13.566	0.003374	0.0647	0.0521	0.0681
107	0.0700	1.165	13.532	0.003469	0.0644	0.0538	0.0679
108	0.0699	1.199	13.498	0.003565	0.0642	0.0546	0.0677
109	0.0697	1.235	13.462	0.003664	0.0639	0.0574	0.0675
110	0.0696	1.271	13.426	0.003766	0.0636	0.0592	0.0674
111	0.0695	1.308	13.389	0.003871	0.0634	0.0611	0.0672
112	0.0694	1.346	13.351	0.003978	0.0630	0.0631	0.0670
113	0.0693	1.386	13.311	0.004087	0.0627	0.0652	0.0668
114	0.0691	1.426	13.271	0.004198	0.0624	0.0672	0.0666
115	0.0690	1.467	13.230	0.004312	0.0621	0.0694	0.0664
116	0.0689	1.509	13.188	0.004429	0.0618	0.0716	0.0662
117	0.0688	1.553	13.144	0.004548	0.0615	0.0739	0.0660
118	0.0687	1.597	13.100	0.004671	0.0612	0.0763	0.0659
119	0.0685	1.642	13.055	0.004796	0.0609	0.0788	0.0657
120	0.0684	1.689	13.008	0.004924	0.0606	0.0813	0.0655
121	0.0683	1.736	12.961	0.005054	0.0602	0.0839	0.0653
122	0.0682	1.785	12.912	0.005187	0.0599	0.0866	0.0651
123	0.0681	1.835	12.862	0.005323	0.0596	0.0894	0.0649
124	0.0680	1.886	12.811	0.005462	0.0592	0.0920	0.0647
125	0.0678	1.938	12.759	0.005605	0.0589	0.0952	0.0645
126	0.0677	1.992	12.705	0.005751	0.0586	0.0982	0.0643
127	0.0676	2.047	12.650	0.005900	0.0582	0.1014	0.0641
128	0.0675	2.103	12.594	0.006052	0.0578	0.1046	0.0639
129	0.0674	2.160	12.537	0.006207	0.0575	0.1080	0.0637
130	0.0673	2.219	12.478	0.00637	0.0571	0.1115	0.0635
131	0.0672	2.279	12.418	0.00653	0.0567	0.1151	0.0633
132	0.0670	2.340	12.357	0.00669	0.0564	0.1187	0.0631
133	0.0669	2.403	12.294	0.00686	0.0560	0.1225	0.0628
134	0.0668	2.467	12.230	0.00703	0.0556	0.1262	0.0626
135	0.0667	2.533	12.164	0.00721	0.0552	0.1306	0.0624
136	0.0666	2.600	12.097	0.00739	0.0548	0.1348	0.0622
137	0.0665	2.669	12.028	0.00757	0.0544	0.1391	0.0620
138	0.0664	2.740	11.957	0.00776	0.0540	0.1437	0.0618
139	0.0663	2.812	11.885	0.00795	0.0536	0.1484	0.0615
140	0.0662	2.885	11.812	0.00814	0.0532	0.1531	0.0613
141	0.0660	2.960	11.737	0.00834	0.0527	0.1581	0.0611
142	0.0659	3.037	11.660	0.00854	0.0525	0.1633	0.0608
143	0.0658	3.115	11.582	0.00875	0.0519	0.1687	0.0606
144	0.0657	3.195	11.502	0.00896	0.0514	0.1743	0.0604
145	0.0656	3.277	11.420	0.00918	0.0510	0.1801	0.0602
146	0.0655	3.361	11.336	0.00940	0.0505	0.1861	0.0599
147	0.0654	3.446	11.251	0.00962	0.0501	0.1922	0.0597
148	0.0653	3.533	11.164	0.00985	0.0496	0.1986	0.0594
149	0.0652	3.623	11.074	0.01008	0.0491	0.2053	0.0592
150	0.0651	3.714	10.983	0.01032	0.0486	0.2123	0.0589
151	0.0650	3.809	10.888	0.01056	0.0481	0.2194	0.0587
152	0.0649	3.902	10.795	0.01080	0.0476	0.2267	0.0584
153	0.0647	3.999	10.698	0.01105	0.0471	0.2245	0.0582
154	0.0646	4.098	10.599	0.01131	0.0466	0.2426	0.0579
155	0.0645	4.199	10.498	0.01157	0.0461	0.2510	0.0577
156	0.0644	4.303	10.394	0.01184	0.0456	0.2598	0.0574
157	0.0643	4.408	10.289	0.01211	0.0450	0.2689	0.0571
158	0.0642	4.515	10.182	0.01239	0.0445	0.2785	0.0569
159	0.0641	4.625	10.072	0.01267	0.0439	0.2884	0.0566
160	0.0640	4.737	9.960	0.01296	0.0434	0.2988	0.0563
161	0.0639	4.851	9.846	0.01325	0.0428	0.3095	0.0561
162	0.0638	4.967	9.730	0.01355	0.0432	0.3207	0.0558
163	0.0637	5.086	9.611	0.01386	0.0417	0.3327	0.0555
164	0.0636	5.208	9.489	0.01417	0.0411	0.3451	0.0552
165	0.0635	5.333	9.364	0.01448	0.0405	0.3579	0.0549
166	0.0634	5.460	9.237	0.01480	0.0398	0.3714	0.0546
167	0.0633	5.589	9.108	0.01513	0.0392	0.3857	0.0544
168	0.0632	5.721	8.976	0.01546	0.0386	0.4005	0.0541
169	0.0631	5.855	8.842	0.01580	0.0380	0.4162	0.0538
170	0.0630	5.992	8.705	0.01614	0.0373	0.4326	0.0535
171	0.0629	6.131	8.566	0.01649	0.0367	0.4498	0.0532
172	0.0628	6.273	8.424	0.01685	0.0360	0.4681	0.0528
173	0.0627	6.417	8.280	0.01721	0.0353	0.4872	0.0525
174	0.0626	6.564	8.133	0.01758	0.0346	0.5075	0.0522
175	0.0625	6.714	7.983	0.01796	0.0340	0.5290	0.0519
176	0.0624	6.867	7.830	0.01834	0.0332	0.5516	0.0516
177	0.0623	7.023	7.674	0.01873	0.0325	0.5758	0.0513
178	0.0622	7.182	7.515	0.01912	0.0318	0.6011	0.0509
179	0.0621	7.344	7.353	0.01953	0.0311	0.6285	0.0506
180	0.0620	7.51	7.187	0.01994	0.0303	0.6576	0.0503
181	0.0619	7.68	7.017	0.02036	0.0296	0.6888	0.0499
182	0.0618	7.85	6.847	0.02078	0.0288	0.7215	0.0496
183	0.0617	8.02	6.677	0.02121	0.0280	0.7564	0.0493
184	0.0616	8.20	6.497	0.02165	0.0272	0.7947	0.0489
185	0.0615	8.38	6.317	0.02210	0.0265	0.8357	0.0486
186	0.0614	8.57	6.127	0.02255	0.0256	0.8805	0.0482
187	0.0613	8.76	5.937	0.02301	0.0248	0.9286	0.0478
188	0.0612	8.95	5.747	0.02348	0.0240	0.9804	0.0474
189	0.0612	9.14	5.557	0.02396	0.0231	1.036	0.0471
190	0.0611	9.34	5.357	0.02444	0.0223	1.098	0.0467
191	0.0610	9.54	5.157	0.02493	0.0214	1.165	0.0463
192	0.0609	9.74	4.957	0.02544	0.0205	1.239	0.0460
193	0.0608	9.95	4.747	0.02955	0.0196	1.322	0.0456
194	0.0607	10.17	4.527	0.02647	0.0187	1.416	0.0452
195	0.0606	10.39	4.307	0.02700	0.0178	1.521	0.0448
196	0.0605	10.61	4.087	0.02753	0.0168	1.633	0.0444
197	0.0604	10.83	3.867	0.02807	0.0159	1.766	0.0440
198	0.0603	11.06	3.637	0.02863	0.0149	1.918	0.0436
199	0.0602	11.29	3.407	0.02919	0.0140	2.091	0.0432
200	0.0601	11.52	3.177	0.02976	0.0130	2.290	0.0428
201	0.0600	11.76	2.937	0.03034	0.0120	2.528	0.0423
202	0.0600	12.01	2.687	0.03093	0.0110	2.822	0.0419
203	0.0599	12.26	2.437	0.03153	0.0099	3.177	0.0415
204	0.0598	12.51	2.187	0.03214	0.0089	3.614	0.0410
205	0.0597	12.77	1.927	0.03276	0.0078	4.187	0.0406
206	0.0596	13.03	1.667	0.03339	0.0068	4.940	0.0401
207	0.0595	13.30	1.397	0.03402	0.0057	6.015	0.0397
208	0.0594	13.57	1.127	0.03466	0.0046	7.608	0.0392
209	0.0593	13.85	0.847	0.03531	0.0034	10.33	0.0387
210	0.0592	14.13	0.567	0.03597	0.0023	15.74	0.0383
211	0.0591	14.41	0.287	0.03664	0.0012	31.72	0.0378
212	0.0591	14.70	0	0.03732	0	∞	0.0373

The value of R, instead of being 53.36, is then

$$\frac{(85.8 \times 0.026784) + (53.36 \times 0.0178)}{0.026784 + 0.0178} = 73, \text{ about}$$

Effect of Temperature on Humidity—If a mixture at 100 deg., having a relative humidity of 0.60, is cooled, say to 90 deg., the relative humidity will be increased. The original 1 cu.ft. of mixture will become

$$\frac{460 + 90}{460 + 100} = 0.982 \; cu.ft.$$

From the table, this mixture originally contained, and still contains $0.60 \times 0.002851 = 0.001711$ lb. of moisture. The maximum amount which it could contain, if saturated, at 90 deg., is $0.982 \times 0.002131 = 0.00209$ lb. The new relative humidity is then $0.001711 \div 0.00209 = 0.82$. Cooling might be carried on to a point at which this figure would exceed 1.0, when some of the moisture would separate out as liquid dew. In symbols,

$$\textit{New relative humidity} = \frac{p_1' w_1}{p_1 w_2}\left(\frac{T_1 + 460}{T_2 + 460}\right)$$

where

T_1 and T_2 = Initial and final temperatures, respectively;
w_1 and w_2 = Corresponding tabular densities;
p_1 = Tabular steam pressure for T_1;
p_1' = Partial steam pressure of the unsaturated mixture at T_1.

Frosts—On a cool night in spring or autumn, the probability of a freezing temperature before morning depends largely on the relative humidity of the air. If this is high any considerable cooling will be likely to increase it beyond 1.0; that is, to cause a condensation of vapor as dew. Such condensation, the reverse of evaporation (which consumes heat), liberates heat and thus tends to keep the temperature from falling further. With a stated temperature at midnight, then, other things being equal, a freezing temperature before morning is less likely to be experienced if the relative humidity is high.

Air in Jet-Condenser Practice

By Everard Brown

While most of the larger steel works and other manufacturing plants operate many engines condensing, it is surprising to note the universally poor vacuum maintained. The range seems to be from 21 to 24 in., and it is seldom one finds an installation carrying 26 in. Manifestly, this condition does not obtain from choice, but rather because of the apparent difficulty, or impossibility, of doing better with the equipment in use.

It might seem that the type of equipment employed is at fault because the jet type of condenser is preferred for general mill purposes, both for central installations serving a number of engines and for individual units. That this is not the case is evidenced by the fact that there are installations where condensers of this type, both barometric and low-level, give as good results, for the service, as the surface type.

Inquiry among mill engineers as to the reason for such poor vacuum will usually elicit the reply that either there is leakage in the exhaust piping or the air-removing capacity of the equipment is too small. To those not familiar with mill-operating conditions, the former reason will no doubt appear inexcusable and reflect on the diligence of the engineer in charge, while the latter will reflect on the manufacturer of the condensing equipment for not supplying a sufficiently large air pump. Full realization of what the mechanical department in a manufacturing plant often has to contend with will materially lessen any blame for leaky piping. The blame can be laid at the door of the condenser builder more often, because he has not given proper consideration to leakage. Perhaps one of the reasons for this is his eagerness to get the order for the equipment, and by offering a smaller air pump he can keep the price down to an attractive figure. Should he get the order and it is found that the air pump is too small, he can always claim that there is excessive air leakage. This is bad practice because the bidder takes advantage of the purchaser, who usually believes that an air pump will be furnished of sufficient capacity to take care of at least a reasonable amount of leakage.

It may also happen that the bidder is not given sufficient reliable data as to operating conditions, in which event he can only base the size of the air pump upon the theoretical quantity of air that will enter the condenser, plus a certain percentage for leakage which, of necessity, can only be a vague assumption. As a consequence, the amount of this leakage is usually underestimated and the air-removing capacity of the condenser made too small.

Proposals for a certain-sized condenser plant were submitted by three different bidders, all based on the same set of specifications. Taking the proposal offering the largest air pump as a standard, it was found that one of the other bidders offered a pump of half the capacity and the third a pump of about two-thirds the capacity, based on an equal number of revolutions for each, which is probably as fair a way of making a comparison as any, because it is a comparison of the durability of the pumps. It is doubtful if the pump having the largest air-removing capacity was large enough, so that it is obvious what the result would be if one of the smaller pumps were put in. The speed at which a pump operates controls its capacity, and in the above instance it was intended that the smaller pump should run at a higher speed, which brings up the question of relatively high maintenance cost.

It would seem that condenser builders have established certain standard sizes of condensers and air pumps for handling given quantities of steam, apparently without due consideration of varying conditions. They can, of course, estimate with accuracy the amount of air that enters with the steam and water, provided there are no unusual conditions with which to contend; and experience should have told them long ago how much additional air-pump capacity is required because of unpreventable leaks.

The secret of a satisfactory condenser installation hinges primarily on the question of air removal, which means an air pump of sufficient capacity to take care of any reasonable amount of leakage. Oftentimes this leakage cannot be prevented because of local conditions, or its prevention proves more expensive to bring about than the cost of the extra steam required as a result of a poorer vacuum. How much better it would be to install an amply large pump and run it slowly during the colder weather or when the outfit is new and more efficient, and then, if necessary, speed it up a little as leaks be-

gin to develop or as the hot weather sets in. Such an installation will also provide capacity for future increase in load on the condenser, a contingency which often arises in mill practice where increasing the load on equipment is common.

It will require a little more steam to operate a larger air pump, but when compared to the losses due to a poor vacuum or to the cost of maintaining an air-tight system, this becomes quite insignificant. A use for this extra steam as it is exhausted from the air pump can nearly always be found if looked for; such, for example, as heating feed water for boilers, an avenue that offers a chance for considerable saving in power costs and possibly one which has been overlooked in many cases.

Test of a 16-Hp. Petter Oil Engine

By Chas. S. Salfeld

Some time ago a 16-hp. Petter two-stroke-cycle semi-Diesel oil engine, made at Yeovil, England, was shipped to this country and subjected to a series of tests by the writer. The engine is of the single-cylinder, vertical, crank-case compression two-port type, 9¾-in. cylinder bore by 10½-in. stroke and running normally at 325 r.p.m. It is provided with a flywheel weighing 1000 lb. and supported by an outer bearing. The exhaust ports open and close at 75 per cent. of stroke and the scavenging ports at 88 per cent.

The fuel-injection pump, owing to wedge regulation, commences to inject at varying times, according to the load. At maximum load this occurs at about 46 deg. before the upper dead center; at rated load about 34 deg.; and at smaller loads, still later. The end of the injection period is constant at all loads and is reached when the crank has almost completed the compression stroke, that is, about 5 deg. before the dead center. The governor raises and lowers a wedge interposed between the pump lever and the pump plunger and thereby graduates the impulses according to the load.

The cylinder head is an adaptation of the well known Hornsby-Akroyd principle. Its upper part, against which the fuel is sprayed, is uncooled but usually remains black. No hot bulb of the generally accepted term is employed, but to facilitate starting a short nickel tube is provided. Water injection into the scavenging port is furnished, although it is not supposed to be used up to the rated load.

The engine is one of several British makes which are widely advertised as being capable of operating with a fuel consumption not exceeding one-half Imperial pint, which would be equivalent to 0.6 U. S. pint, or 0.075 U. S. gal. While the writer is convinced that such economy can be and is obtained with thoroughly well designed engines of this class, neither he nor several of his assistants were capable of realizing such consumption on this particular engine. The very best they ever obtained, but not by any means the average, was 0.597 lb., or 0.0886 U. S. gal. of 42.5-deg. distillate, which is an excess of 18 per cent. The cause was not far to seek and presented itself in the unreliable performance of the fuel pump and injector. Further satisfactory characteristics of the engine are its capability of operating without water injection even beyond the rated load, its high mechanical efficiency, and the equally high volumetric efficiency of the crank-case air pump.

Particularly by eliminating the water injection have the makers solved a problem which, of late, has been a source of considerable trouble and anxiety to a number of manufacturers. This has been done partly at the expense of power output. Until early in 1912 this size of engine was rated at 20 b.hp. and water injection was used. The makers then decided to rate it at 16 b.hp. and abandon the use of the injection water. The writer operated the engine at the maximum load the governor would permit, namely, 23 b.hp., then removed the governor wedge so that more oil could be admitted, and it was evident that a considerably higher horsepower might yet have been developed with water injection.

During the principal trials the fuel used was distillate of 0.826 sp.gr., or 39.5 deg. Baumé. Tests with crude oil and with fuel oil were also made, and these will be found appended. The first named tests gave the following results:

Approx. Load	0	¼	½	¾	⅞	1	1⅛
B.hp.	0	4.025	8.1	12.3	14.9	16.45	22.1
R.p.m.	338	335	335	335	334	334	318
M.e.p.	12.6	14.0	19.6	24.6	29.2	30.1	38.5
Net i.hp.	8.45	9.3	13.0	16.3	19.3	19.9	24.25
Net mech. eff.	0	43.3	62.3	75.6	77.3	82.7	91.1
Oil per b.hp.	...	...	...	0.636	0.627	0.613	0.635

The average volumetric efficiency of the crank-case air-pump was 80.4 per cent., which was practically constant at all loads. At maximum load (22 b.hp.) the scavenging pressure was 3.6 lb. per sq.in. and the compression pressure 140 lb. The explosion pressure varied from 250 to 318 lb. and the exhaust pressure was about 28 lb.

The following test was carried out with Peruvian crude oil of 0.895 sp.gr. (26 deg. Baumé), 105 deg. F. flash point, and 18,601 B.t.u. per lb.:

B. Hp.	R.p.m.	Fuel per B. Hp.-Hr. Lb.	Fuel per B. Hp.-Hr. U. S. Gal.	
16.4	334	0.625	0.0837	With injection water
16.3	332	0.638	0.085	Without injection water
15.5	335	0.618	0.083	
14.2	338	0.626	0.084	
10.0	340	0.761	0.102	
5.2	344	1.23	0.165	
0	345	5.42 per hr.	0.726 per hr.	

The consumption of 28 deg. fuel oil (0.886 sp.gr.) was as follows:

B. Hp.	R.p.m.	Fuel per B. Hp.-Hr. Lb.	Fuel per B. Hp.-Hr. U. S. Gal.
15.9	322	0.646	0.087
14.9	324	0.676	0.091
9.5	325	0.893	0.121
5.1	334	1.33	0.18

The best consumption obtained with 42.5 deg. distillate was:

B. Hp.	R.p.m.	Fuel per B. Hp.-Hr. Lb.	Fuel per B. Hp.-Hr. U. S. Gal.	British Imperial Pints
15.1	326	0.597	0.088	0.59
13.8	328	0.606	0.089	0.598
9.85	335	0.703	0.104	0.694
5.1	333	1.456	0.217	1.435

The regularity of running was satisfactory except at no load, when considerable "hunting" occurred. This was not due to any defect in the governing apparatus, but to insufficient heat in the combustion chamber, the compression pressure of 140 lb. apparently being a little low. Nor did this "hunting" occur with all fuels; with crude oil it was altogether absent, but with fuel oil and with distillate it was distinctly noticeable. A throttle valve on the air inlet would have been a remedy, but none was provided. The exhaust was visible with all fuels and at all loads, but was in no way objectionable.

Effect of Temperature on Capacity of Centrifugal Pumps

By John Howard

At a recent test of a centrifugal boiler-feed pump an opportunity was afforded to determine the effect of varying temperatures upon the capacity. It was a standard Platt 3-in. three-stage pump, driven by a Terry steam

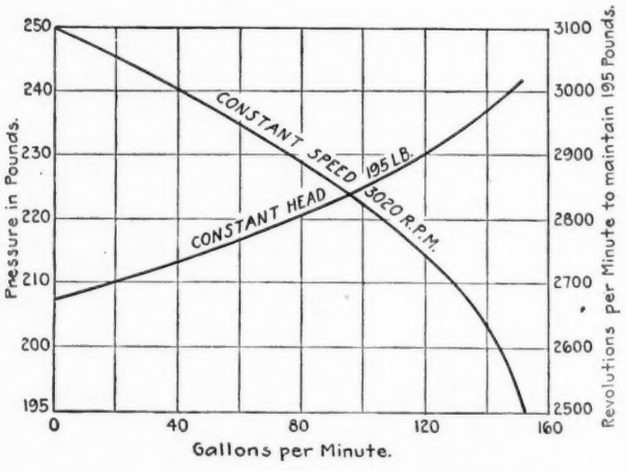


Fig. 1. Capacity Test for Constant Head and Constant Speed

turbine, and designed for 150 gal. per min. against 195 lb. pressure at 3000 r.p.m. As the head on the suction was only about 30 in. above the center line of the pump, the builders would not guarantee to handle water at a temperature greater than 180 deg. F. The water was measured by a G. E. flow meter which was afterward calibrated and found correct.

The capacity test gave the results for constant head and for constant speed, shown by curves in Fig. 1. The

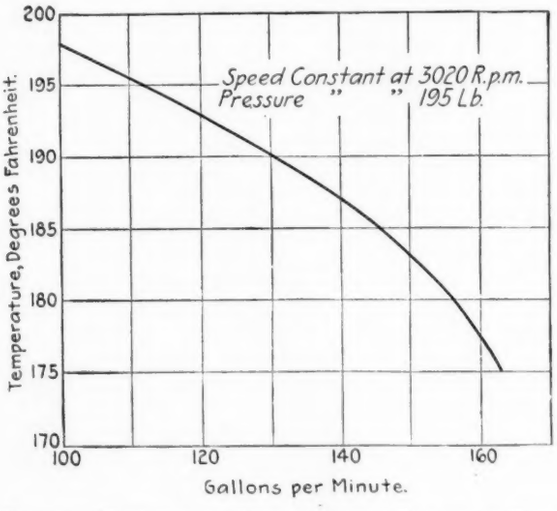


Fig. 2. Results of Temperature-Capacity Test

first curve was obtained by the use of a pump governor, and the second when the governor was cut out, the capacity being varied by throttling the discharge.

In order to make the temperature-capacity test, the temperature of the water in the open heater from which the pump took its suction was varied by controlling the amount of steam passing into it. The result is shown by the curve in Fig. 2. The great variation is undoubtedly due to the extremely small head on the suction side of the pump.

While the guarantee was for only 180 deg., it was found that by speeding up the pump somewhat, water at 190 deg. could be handled safely.

Power Costs in a Tenant Building

By Alfred A. Winter

At a time when we are all interested in figures on economical power costs, based either on theoretical calculations or test results of newly constructed uptodate equipments, I venture to show cost figures from an out-of-date plant, such as a large number of engineers have in their care. These figures are not record breaking, and no doubt some who are skilled in obtaining real efficiency will throw up their hands in dismay. But the thought that it is sometimes well to see ourselves as we really are, impels me to show our figures for 1913 and 1914.

The plant has two Babcock & Wilcox boilers (total normal rating 475 hp.) equipped with Murphy furnaces, and one deck tubular boiler, flat-grate, 150-hp. in reserve, and two high-speed, single-valve engines—one a 22x18-in. and one a 14x14-in., also a 10-kw. direct-connected unit for night lighting, as the plant runs only in the daytime. The larger engine has two driving pulleys on its shaft, one running a belt drive through certain of the buildings and one driving a 100-kw. belted generator.

The smaller engine is direct-connected to a 75-kw. generator. The power is about equally divided between shaft and electric drive and is used for various purposes of manufacturing, this being a property with tenants, to whom power is sold.

POWER COSTS FOR 1913 AND 1914

Items	1913	1914
Taxes	$562.50	$562.50
Insurance	225.00	225.00
Water rent	500.00	500.00
Coal	6,420.45	5,305.65
Labor (operating)	4,144.00	4,151.50
Labor (extra repairing)	503.45	373.01
Supplies for operating repairing—		
Oils	171.66	136.34
Packing	47.71	13.26
Boiler compound	136.50	134.62
Boiler-room supplies	51.05	68.80
Furnace and stoker supplies	264.35	.....
Pipe, valves and fittings	49.31	119.44
Lumber and millwork	.....	3.58
Sand, cement, stone and lime	.....	9.35
Electrical supplies	32.42	43.56
Tools	14.07	40.04
Hardware	.....	4.71
Miscellaneous	13.90	34.13
Repairing (outside labor)—		
Boiler, furnaces and stokers	283.10	314.13
Engineer and pumps	133.30	12.00
Electrical	10.88	24.50
Belts	7.55	.....
Roofs, spouts, etc.	.....	38.58
Stack	315.30	.....
Pipe fittings	.....	324.00
Miscellaneous	3.50	50.30
Total operation and repair expenses	$13,890.00	$12,489.00
Depreciation on $37,500 (4 per cent.)	1,500.00	1,500.00
Total	$15,390.00	$13,989.00

Horsepower	1913	1914
Generated at boilers	428	382
Loss—condensation, friction and transmission	85	85
Delivered to tenants	343	297
Cost at boilers (without depreciation account)	$32.50	$33.00
Cost at boiler (with depreciation account)	36.00	37.00
Cost delivered to tenants (without depreciation account)	40.00	42.00
Cost delivered to tenants (with depreciation account)	45.00	47.00

Operating Hydro-Electric Plants without Attendants

By J. M. Wanchope

Two power plants were recently installed by a mining company in northern Idaho, which are normally operated without attention, except once a day when the mine electrician looks them over.

The company buys most of the power used in its mine and mill, it being delivered at 2300 volts, three-phase. Having several water rights on small streams, it was decided to put them to use. One location was a short distance from the mine, where a head of 400 ft. with sufficient water to develop 150 kw. could be obtained. Another was found where, by utilizing three small streams with heads of 100, 160 and 250 ft., respectively, sufficient water to develop another 150 kw. was obtained.

The waterwheels used were of Pelton type with belt drive to the generators. As the plant had three heads, three wheels were secured to one shaft, each being adapted to a different head. The nozzle of each wheel was fitted with a deflector to direct the water from the wheel without stopping the flow.

Each plant was fitted with a common flyball engine governor, driven by a belt from the wheel shaft and so adjusted that with a rise in speed of from 5 to 10 per cent. above normal a small weight was released, which in falling released a heavy one. This was so connected to the deflector lever that the latter was moved to a position to cut off the water from the wheel, causing the unit to stop.

The generators operate in parallel with the power company, feeding into the mining company's lines on the customer's side of the meter, thus decreasing by their output the power purchased. The electric company thus provided the governing, as the generators were operated under constant load, the nozzle being set according to the amount of water available.

Automatic switches were used for the generators with no-voltage and overload trips on them. In case the electric company lost their load the effect was practically the same as a short-circuit on the small plants, due to the heavy load thrown on them. The switches would then instantly open, and the wheels and generators would start to speed up, causing the trip on the flyball governor to release the weights which raised the deflectors, thus shutting down the units. Of course, when this happened the electrician at the mine or mill knew that the load had been dropped and started the units up again as soon as the power company had returned the voltage to their line.

As the mining company was billed for the power used partly on the maximum amperes drawn from the line of the power company as determined by a graphic ammeter, it paid the mining company to keep the peak as low as possible. The two plants were operated with a leading power factor up to the capacity of the generators in current, to keep the current drawn from the line as near unity as possible, the mine load being composed of induction motors and naturally lagging. Power-factor meters were installed at each plant and in the substation of the power company on the mining company's feeder. The plants operated nicely under these conditions. There would have been no returns if an attendant had been kept at each plant, but under the conditions as stated they returned a fair interest on the investment.

Just for Fun

[More stories of stupidity and ignorance competing with "Some Original Ideas," as printed Jan. 19, 1915.]

Still Thirsty

A chief of a small electric-light plant, being somewhat dry on sundry occasions, decided to tap the line leading to his boiler-feed pump, where cool palatable water was being handled. What was his surprise to find his dipper dry! He had tapped the suction which operated under 12 or 14 inches of vacuum.—*J. W. Fowlkes, Denver, Colo.*

Now It Surely "Has Came"

El Dorado Republican and Weekly Nugget

Published Every Friday by D. A. RICHARDSON and W. S. KIRK Proprietors.

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A STEAMLESS ENGINE.
A NEW POWER MOTOR.

After the horseless carriage and wireless telegraph now comes the steamless engine; a rotary power motor that revolves of itself without the aid of steam, heat, oil, gas or electricity, or any other external source of energy, and gives forth power that can be employed and made use of.

It could be called a "wheel within a wheel" motor, or a "planetary" motor, as, like a planet of the solar system, it revolves of its own momentum. It is in the shape of a fly-wheel or pulley and turns on an axis or shaft; being practical and efficient and simple of construction. It is called the Burr Evans Motor. The inventor is a practical mechanical and mining engineer now in Placerville.

The motor can be made of any size desired; from one inch to forty feet or larger in diameter. The smaller sizes will keep clocks wound-up and furnish power for any and all purposes about the home and farm. When a large amount of power is required, to operate for instance, a large electric generating or pumping plant, ten or more of the larger size motors can be attached to one axis or shaft. The medium size motors, from one to five meters in diameter, will be the most used on and about farms and for pumping water cheaply to irrigate lands to raise food-stuffs and for compressing air for mining and mechanical work.

The cost of operating the motor is infinitesimal. After the principle involved, that causes the motor to revolve, is understood, it is plainly evident that it will operate and supply power As a cheap power producer it will be a great and lasting benefit to mankind in general. It is so simple that the wonder is not that it has been thought of, but that it has been delayed so long.

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A New Power-Creating Motor.
No External Energy Required.

A machine, that could be called an "Automatic Fly-Wheel Power Motor," which will supply power at a very nominal cost per horse-power, has recently been perfected. It creates energy automatically, on about the same hypothesis as water is raised gradually from the ocean surface upward and floated as clouds inland and dropped as rain, which eventually falls in a large body as at Niagara and creates power, and then returns to the ocean-sea and rises again, and thus goes round and round as it were, producing power each time on its downward course. Thus it is with the Burr Evans Motor

The machine is based on an entirely new principle of an automatically revolving flywheel, which of its own momentum gives forth power in any quantity desired, according to the diameter of the motor, which can be from one inch to fifty feet or more. And where a large amount of power is required, twenty or more of the larger size motors can be placed on one center-shaft.

After the motor is placed in operation the cost of producing power will be only the ordinary wear and tear of the machine, which can be cut down to next to nothing per horse-power by using the modern hard and tough metals and self-oiling ball bearings in the construction of the machine. The motor can be made in quantities at a very reasonable cost, and it requires no care or attention when in operation.

The motor will be especially useful and beneficial to mankind in general for generating electricity at a nominal cost at any place in small or large quantities, and for pumping water cheaply for irrigating farm lands to raise foodstuffs for the increasing millions of human beings.

The inventor, Mr Burr Evans, is a practical mechanical and mining engineer and is now at Placerville.

It is true of most discoveries, that after they are brought to light they are almost self evident. Thus it is with the Burr Evans Motor

Mountain Democrat

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SATURDAY, FEBRUARY 20, 1915

Achievement.

In the February (1915) issue of "Riches," a monthly journal published at Ruskin, Tenn. there is an article headed "Achievement," from which the following is an extract:

"So much has been accomplished lately, and in such a short time, that no one dares to say that anything is impossible, for so many of the things that are in every day use, were once —only a short time ago—said to be impossible. But today we are used to seeing the impossible accomplished."

Thus it is with the Burr Evans Automatic Fly-Wheel Power Motor; at first thought it may seem impossible that the Motor will operate of itself as claimed, but like the sewing machine, the wireless, etc., after the principle is seen and understood, it looks simple and a matter of course, and the only wonder is that it was not thought of sooner.

In the same issue of said journal is another article in regard to obtaining energy direct from coal. In which it is stated as follows, to-wit:

"When it is attained, an almost incalculable addition will be made to the mechanical energy employed by man. The idea of taking power direct from its natural sources is in accord with the spirit of the age. We are becoming impatient of the old, indirect, cumbersome ways, and what is more important, we are beginning to appreciate better the wastefulness of many of them. But in the case of coal it would seem that still another step would be made which would carry us back of coal itself to the source of energy that we find stored in it. That source is the sunshine."

And *Sunshine* is simply diffused electricity held in suspension in the atmosphere, as it were, and all it requires is an electric generator, operated by some inexpensive method, to gather in and consolidate this electric-sunshine energy in any quantity desired to be used for Power at any place and at any time. And the Burr Evans Automatic Flywheel Power Motor will supply the inexpensive method with which to continually operate millions of electric generators at every place in the world where power may be needed.

(Reproduced from clippings received anonymously)

Where the Water Went

It is necessary to carry a rather high pressure of steam at the Depot building here, and the water comes back so hot that steam comes out of the overflow, which I can close, as it is in the boiler room.

One night, while I was cleaning fires, the tank ran dry and I opened the make-up valve, leaving the overflow closed, which backed the water up in the return pipe. On discovering my mistake I opened the overflow and relieved the pipe. In the meantime the car inspector had tapped the pipe in the building to heat wash water and, having placed his bucket of water and turned on the steam, stepped outside a moment. On returning he found the bucket empty, and accused his partner of emptying it. Although he is supposed to thoroughly understand steam heat, he still contends that his partner, instead of the engineer, emptied the water.

This is amusing, but not the most stupid occurrence that has come under my observation.—*Willis W. Nelson, Spokane, Wash.*

A Leaning Chimney Plumbed

By Thomas S. Clark*

Many methods have been employed to bring back to the vertical position tall columns such as chimneys, shafts, towers, and the like, which have leaned or settled out of plumb. The procedure has often been very expensive and hazardous as well as slow. In the case of chimneys it has compelled shutting down the boilers and a consequent loss in output of the manufacturing plant. A new, unique and inexpensive method was recently employed to straighten quickly a 100-ft. factory chimney in Brooklyn, N. Y., without interruption to the plant.

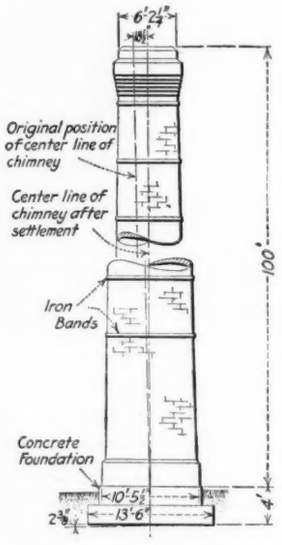


Fig. 1. Leaning Chimney in Brooklyn, 100 Ft. High

The Problem

Under one side of the foundation the soil had softened, and settlement had taken place, due to leakage from a water pipe near the foot of the foundation, whose existence had been forgotten. Fig. 1 shows the leaning chimney.

To excavate on the low side of the foundation to the depth of the footing course, crib under it, and attempt to jack the structure back plumb, would have involved large cost, loss of time, and not a little risk. The great weight of the 100-ft. column and the additional pressure due to the leaning would have required powerful jacks and a substantial footing to jack against. There would have been danger also of cracking the unreinforced spread foundation, and additional foundation would have had to be placed before the jacks and cribbing could have been removed safely.

Another method to straighten a leaning chimney, employed to some extent in Europe, is to saw out a course or a portion of a course of brickwork on the side of the columns away from the direction of lean, in wedge-shape, with an ordinary two-man crosscut saw, and allow the portion of the chimney above the cut to settle back. This method is, to say the least, not entirely satisfactory nor does it remedy the defect entirely, as the portion below is still out of plumb and the bearing surface of the foundation footing is not brought to the horizontal. For these reasons these two methods were abandoned.

The chimney was in operation, so it was not possible to determine the amount of its lean by plumbing to a center on the inside. The deviation from the vertical was therefore determined with a transit by a simple triangulation; it was found to be 18½ in. From this figure, with the known height of the chimney, it was determined that the toe of the footing on the high side must be settled 2⅜ in. on a line exactly opposite the direction of the lean. The problem was to remove just enough earth between the center of the foundation and the toe of the high side to gradually settle the foundation back 2⅜ in. at the toe. Levels were taken on the high side and an indicating plumbline fastened to the side of the chimney.

How the Work Was Done

A trench was excavated on the high side to the depth of the foundation, about 4 ft., the length of the trench equal to the square side, and its width equal to half the width of the foundation, or about 8 ft. Four 2-in. wrought-iron pipes, 8 ft. long (half the width of the foundation), were sharpened sawtooth fashion at one end. These pipes were successively driven under the high side of the foundation near its center (Fig. 2), then withdrawn, and emptied of the material in them by driving a steel rod through the pipe. Successive insertions were made about a foot apart. As the pipes were withdrawn, the adjacent earth crushed into the holes left.

In this way but a small quantity of earth was removed at a time, and but a small quantity gave way at a time; the yielding occurred just where wanted. The chimney settled back gradually, with no shock or no danger. The amount of settlement, its direction, and the rapidity of settlement were always in absolute control. The telltale plumb-bob gave the direction as well as the amount of movement.

At one period of the operation the chimney began to settle slightly out of line. It was only necessary to drive the pipes more often at a certain point to bring the shaft back to line.

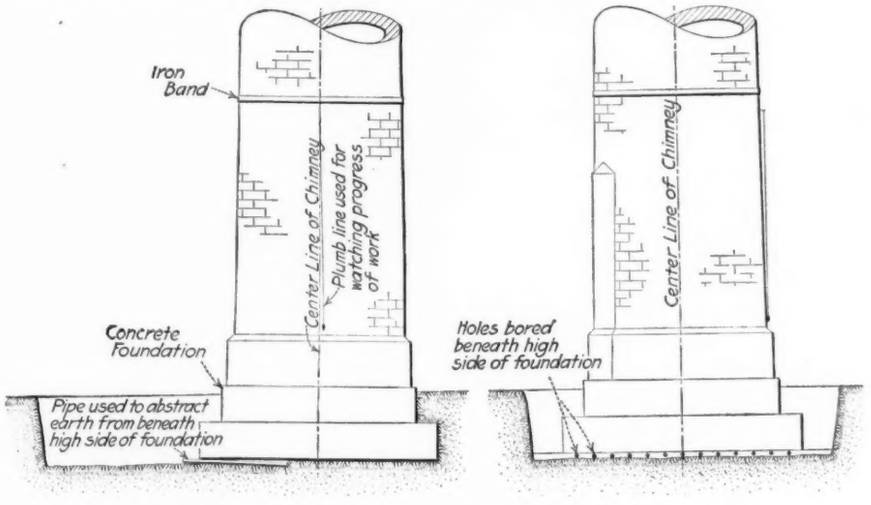

Iron Band
Center Line of Chimney
Plumb line used for watching progress of work
Concrete Foundation
Pipe used to abstract earth from beneath high side of foundation
Holes bored beneath high side of foundation
Center Line of Chimney

Fig. 2. Method of Removing Earth under High Side to Bring the Chimney Back to Plumb

When the column was again plumb the trench was filled up. The underground leak in the drain pipe had been previously stopped to prevent further softening of the earth on one side. The chimney has since remained intact.

The work was done by the Alphons Custodis Chimney Construction Co., of New York. The method was devised by the writer.—*Engineering News.*

*Engineer, Alphons Custodis Chimney Construction Co., 99 Nassau St., New York City.

Editorials

The Engineer at Public Hearings

Operating engineers seldom have to address legislative committees, public-service commissioners or municipal officials in formal hearings, but when they do it is worth while to know how to do it. As a class, engineers are men of deeds rather than of words, while lawyers are fairly characterized by the latter qualification. It is not easy to carry a petition successfully through a public body, and the causes which tend toward failure in this direction deserve careful consideration.

Engineers seeking legislation or other regulatory action must first of all present their cases upon the solid foundation of facts. Hearsay evidence cuts very little figure with the average committeeman, but a few essential facts and figures throwing light upon the problem in hand, set forth in a plain, logical way, will do wonders in commanding a respectful hearing. Often it pays, no doubt, to club together and retain counsel to look after the legal side of proposed measures; but above all, it is essential to stick absolutely to known facts and conditions and not to attempt to strengthen the case by introducing evidence of uncertain nature. It is better to say "I don't know" a hundred times in a forenoon before a committee, when the witness or proponent of a measure is not fully informed, than to try to "bluff through" on suppositions—a lesson that is none too easily learned in other walks of life.

A fair degree of consideration for the views of one's opponents is desirable, so far as it does not jeopardize the objects of the petitioners. Thus, a bill may be drawn to limit central-station rates in a way that will make life more tolerable for the plant engineer. The latter ought to be able to gain his object without attacking the desirability of giving existing capital a reasonable return. In advocating any measure the proponents ought to be prepared to meet the question of its effect on present business organizations. One of the greatest defects seen in legislative committee rooms is the inability to see more than one side of a question—a defect which narrows the character of evidence presented and often leads to disaster when the finding comes through. The engineer cannot be expected to present a case with the skill of a Webster or a Choate, but he can certainly make sure of his facts and stand on those, even in the face of severe cross-examination. Restraint in advocating any cause goes further than excessive one-sidedness.

Recent observation of the work of engineers in hearings emphasizes the importance of presenting only pertinent data, of avoiding tempting side-issues and personal grievances not affected by the proposed measures, and of putting in evidence bearing toward a definite demonstration of the need for a given bill. The burden of refuting a measure may be thrown upon the engineers' opponents in many cases. The avoidance of needless work is as important as the presentation of facts bearing directly on the matter in hand. Mere assertions that a bill is desirable count for little. Coöperation is absolutely essential in "framing up" a proper line of attack in supporting legislation on behalf of the engineer, and simple, direct methods are invaluable in dealing with public authorities.

There Is No Royal Road

Knowledge is not to be found by waiting with idle brain and hands. Knowledge may be acquired only by those whose desires are sufficiently strong to urge them to make the effort, both mentally and physically, to win it. The fields of knowledge are unfenced. There are no barbed-wire entanglements to obstruct the way, no trenches across the road, to be won only by fixed bayonets and the strenuous charge or spectacular bravery. Neither is the road to knowledge the velvet-covered royal way made smooth by the toil of others. He who seeks must build the road for himself. Each step means the expenditure of time and effort, with no limit upon the results that may be attained, except the self-imposed limitations of the seeker.

The means of acquiring knowledge are within the reach of all. Free libraries and reading rooms are open to all who care to enter, and in them may be found books and periodicals covering almost every subject. Attendants are there who will inform the seeker where he may find books and articles upon the desired subject. A letter, costing two cents to mail and inclosing a stamp for a reply, will bring an answer or suggestions as to where the answer to nearly any question may be attained, not obtained. The printing press has made books low in cost, and reasonably few are required to cover any one line of research. But no book is of any use until taken from the shelf and opened. Ages ago someone said, "You must creep before you can walk, walk before you can run." The aviator does not jump into his machine and immediately reach the height of the clouds. The tower is not started at its full height and built down to the ground.

In building the tower the first step is excavating for its foundation, by clearing away the soft, springy surface to a firm footing. A foundation must be laid before the builders are ready to start on the tower. The aviator starts his machine on the ground and gradually rises. In learning to walk each step in advance must be made by itself and completed. There is no short cut; no royal road. Experience is the only real teacher. The higher branches of any subject cannot be understood until the beginner has learned to understand the fundamentals of that subject, has learned to reason, and each one must learn to think for himself. No power outside of the individual can cause his brain to work. No power can teach unless the brain is ready to receive and able to understand. One may be able to repeat a rule, parrot-like, word for word, but unless the reason for that rule is clearly understood it is of little value, for it cannot be applied with intelligence.

Charting the Plant

How many engineers can show a blueprint or any kind of a plan of any portion of their plant, or of any of its equipment? How many have a list of the machinery in their plant, giving information in regard to its size, date of installation, make and purpose? Yet without these, they cannot promptly answer requests for information from the head office.

Construction plans showing the relative locations of pipes and the different pieces of apparatus, of electric-wiring ducts and panel boards, of valves and the purpose they serve are often laughed at when the apparatus is installed. They help, however, in later locating new equipment without interference from a long forgotten sewer or buried pipe line. It is often hours and weeks before the new man on the job is broken in and can perform all the duties of his position without questioning one of the older men. In the one-man plant many tedious hours are spent in doping out the various lines of pipes and their valves. Many a shutdown is caused by the lack of some simple little diagram or plan, one that a man could make in a week or even a day. What the lack of that plan costs can only be measured by the size of the plant affected. One man's time for a week may be forty hours, which is the same as forty men losing one hour each, or four hundred losing six minutes each. And six minutes is a very short shutdown.

The lack of plans is rarely the fault of the engineer, the man in charge of the plant. He often has all that he can do to keep it running. Lack of plans is due to the endeavor to cut down cost, that terribly high first cost, and often to trying to save time, because it would take too long to make a drawing to scale. No one seems to realize that if the scale drawing is not made in the office before construction, a full-sized model is built in the field by cut, try and fit methods. You can get out of paying for the drawings, but you cannot escape paying for the unnecessary waste of time caused by the lack of drawings. True, you may not be able to see the amount you pay for measures made in the field, for cutting and fitting, but pay you do, either in money or in time, not only in the first cost, but in upkeep, in making repairs.

Lubricants

Lubricating oils are made up from a few easily obtainable base oils or greases. The number of combinations and their proportions are unlimited, but the function which each ingredient has in the compound appears to be unknown to the purchasing public. We do not know exactly what qualities are improved by adding certain oils, or whether what are popularly known as adulterants may not be better than the oils with which they are mixed. Knowledge of this kind can only be gained by long and careful test, the expense of which no one firm should stand.

If a consumer understood why John Smith's No. 3XX oil is all right in the heat of a closed engine room, but refuses to work after the room is properly ventilated, he could discuss the oil question more intelligently. As it is now, oil is bought on representations of the most general sort and on the trial and error system. There is not always a certainty that the same brand of oil does not change while it is being stored by the purchaser. Who knows what the effect may be of pouring a new barrel of oil into a tank in which there remains a few inches of some old oil, especially when he knows the composition of neither? There may be chemical changes going on even with mineral oils. We can be confident that there are changes with time if the oils are of animal or vegetable origin.

This is a serious problem. It is not so much that the saving in oil would amount to much. It would not, but the saving in power is important. Power is mostly generated to be transformed into heat by way of friction. In some sections of the country power costs so little that it has hardly to be considered, but generally, the engineer is held responsible for the size of the coal bill, and a man who can cut the consumption is worth more than one who does not take into consideration all the possible wastes that may be going on. In some plants the engineer's responsibility is assumed to end at the door of his plant, but most owners would welcome his assistance in reducing costs, even to his suggesting the oil to be used in the shop or mill. The man whose pay envelope depends on the low cost of power has a right to ask that every precaution be taken to see that his power is intelligently consumed.

This problem is too large and of too universal interest to expect that any one maker of oil will shoulder the burden. Some university or other public institution should assume it. We know much about oils, but our knowledge is based more on their manufacture and chemical composition than on physical tests, and while the composition of an oil may be duplicated if known, it is its physical properties that interest the engineer.

Dissatisfaction in Massachusetts

If the present engineers and firemen's license law in Massachusetts is so woefully wrong and objectionable as the supporters of the new license bill would have us believe, it seems strange that it should have taken about twenty years to find it out.

No matter how good a law may be, it will not find universal favor. The present law in Massachusetts may have its little defects. Even so, why should a new bill be introduced? Are amendments to the present law, where needed, impossible? Those for and those against the bill now before the Massachusetts legislature should know that the function of license laws is to promote public safety. With this in mind as the fundamental basis to work on, the present situation ought to be easily adjusted to the satisfaction of all without destroying a law which, on the whole, has been long and widely recognized as good.

The letter, "Live Steam vs. Live Men" on page 412, is printed, not because of its news value, for there is nothing unique about it, but to call attention again to the dangerous conditions that are permitted to exist and the necessity for regulations which will prevent them. How naïve the observation that "It (the bill) was supported by a number of engineers and opposed by a number of manufacturers."

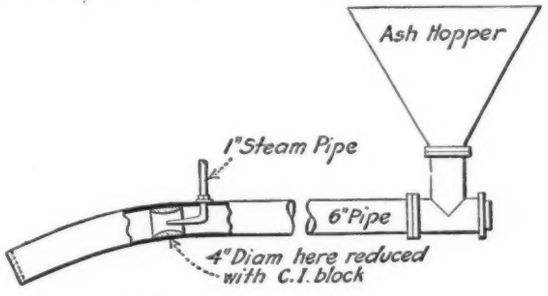
"Aye, there's the rub."

When a daily paper thus throws its influence against a good measure, it is only natural that its motives should be questioned.

Correspondence

Live-Steam Ash Ejector

E. H. Clarke inquires in the issue of Dec. 22, 1914, as to why his ash ejector will not work. I believe that if he will plug the end of the 6-in. pipe at the hopper end and fit a nozzle about 7/8 in. diameter, as shown in the illustration, about three feet from the discharge end, he will get



VACUUM ASH HANDLER

over his trouble, as it is far easier to draw ashes out by a partial vacuum than to blow them out. At the same time, I think that less steam will be taken with the suction outfit, although steam ash ejectors of any type are very wasteful and should not be used if it is possible to use an elevator or conveyor.

E. R. PEARCE.

Rochdale, England.

Protecting Dry Batteries

Dry batteries are used extensively for operating bells, tank signals, ignition work on engines, etc., and to many engineers it is a constant source of worry to keep them in good condition. The nature of the work demanded of the batteries often calls for their use under damp, hot, dry or other unfavorable conditions. The life of the average dry battery depends more on the conditions in which it works than on the actual current drawn from it.

The writer has adopted the scheme of protecting batteries from dampness and changes in temperature by covering them with paraffin, the results being not only increased life of the battery, but also increased efficiency. All that is necessary is to secure a light wooden or even pasteboard box large enough to hold the required number of cells and sufficiently tight to hold melted paraffin. The box should be of such a shape that the batteries may be set on end with about half an inch between cells, and deep enough so that they may be covered completely, including binding posts and connections, to a depth of at least half an inch. The batteries should be connected as usual and the terminal wires led outside the box where a switch may be connected if desired. Paraffin is then melted over a steam bath or in a double boiler and the box filled. It should be remembered that the paraffin will shrink in cooling, and for this reason it is necessary to cover the batteries to a considerable depth to insure their being completely covered after cooling.

A set of cells fixed in this manner is waterproof and proof against drying out. They will last at least twice as long as they would if not covered. The writer has records of sets that have given service in ignition work for from sixteen to twenty months. For bell work they should last longer. The cost of covering the batteries in this manner is very small. Any suitable-sized box may be used and the cost of paraffin is not over twenty-five cents for a set of four batteries.

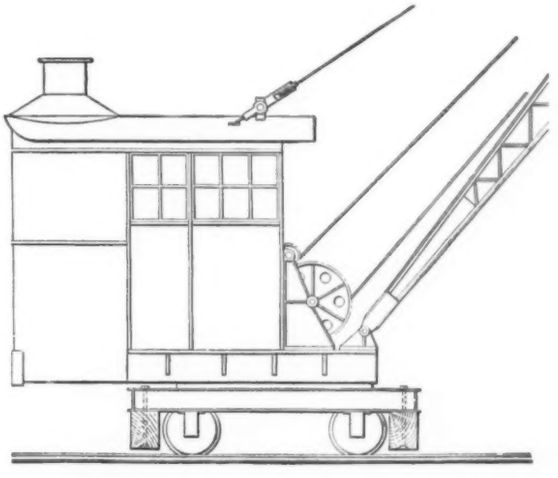
JAMES H. BEATTIE.

Washington, D. C.

Operating a Locomotive Crane

On a locomotive crane which I was operating, the bottom of the truck frame was about 24 in. from the top of the rail. When the wheels jumped the track the first thing to strike was the bottom of the axle boxes, and the weight of the apparatus (about 70 tons) would fall on the boxes on one side, meaning that two new boxes (if all four wheels went off the rails) had to be replaced before the crane could be operated again, beside letting the crane sink down to the axles, as the track was laid on filled-in ground.

To overcome this difficulty I used two timbers that were in the old lumber pile and bolted them fast under



TIMBERS UNDER CRANE TO PREVENT DAMAGE AND FACILITATE REPLACING WHEN DERAILED

the truck frame, leaving about a two-inch clearance between the bottom of the timber and the top of the rails. When the crane jumped the track again it could only sink two inches and rest on the timbers both back and front. After that it was only necessary to swing the loaded bucket over the rails, raise it to the top of the boom and lower the latter till its weight together with that of the bucket overbalanced the back end of the crane. Then when the wheels were clear of the rails, by setting a jack or a heavy block on a slant against the side of the frame and raising the boom, the crane would tilt over and the wheels would fall back on the rails. When one end was

on the rails the position of the boom was reversed and the same operation performed on the other end.

Instead of taking four or five hours with five or six men, as formerly, to get the crane back on the track, it takes about fifteen minutes with one man besides the operator. No heavy lifting, no broken boxes, and little loss of time.

JOHN H. HONEY.

New York City.

Cost of Operating Vacuum Ash-Handling Systems

In the Feb. 9 issue of POWER the Girtanner-Daviess Co. revives the discussion on the cost of operating vacuum ash-handling systems, which was carried on in the issues of July 7, Sept. 8 and 15, and Oct. 20 of last year.

In this discussion the error is made of assuming that repairs and depreciation are synonymous. The yearly repair cost of $32 is compared with the 40 per cent. depreciation of the system given in my previous discussion. The fact that the cost of repairs for the first year is but a nominal sum is no assurance that the equipment will not go down in the second year of its operation. To get at the actual rate of depreciation, the two years and more would have to be considered. Any system of accounting that does not take into consideration all the items comprising the cost of ash removal, and that over a number of years, is going to prove misleading.

While it is true that my experience with the vacuum system of ash removal was limited to a single installation, and that of the blower type, it nevertheless gave me a good impression of the abrading power of swiftly moving ashes on iron and steel pipe, with its consequent effect on the cost per ton of ash removal.

From an operating standpoint, success or failure of a vacuum ash-handling system depends on the amount and composition of the ashes. An installation that is considered a success in the East where a low-ash coal is available may prove a failure in the West where coal running upward of 20 per cent. ash containing a high proportion of silica is frequently encountered.

There is no denying that the vacuum system of ash removal is a convenience so far as the labor of handling is concerned, although pulling and breaking clinker into a 6-in. hole is not so convenient as pulling them into a bucket conveyor or car, and if the cost can be kept down to a reasonable amount, the vacuum system should soon prove itself the champion in its field. Personally, however, I do not look for its general adoption.

C. O. SANDSTROM.

Kansas City, Mo.

The article in the Feb. 9 issue emanating from Messrs. Girtanner-Daviess is interesting reading. Discussion of engineering questions, however, in an engineering journal should be accompanied by such array of data as will be really informative to engineers. The information given in the letter referred to does not constitute engineering data, but I trust that from the experience of Messrs. Girtanner-Daviess such data may shortly be forthcoming so that engineers may receive some much needed information concerning a system or plan which has its undoubted merits.

GEORGE L. PRENTISS,
Parson Mfg. Co.

New York, N. Y.

In reply to the above letters by Mr. Sandstrom and Mr. Prentiss of the Parson Manufacturing Co., we have the following to offer: Since our last letter we have had the opportunity to investigate one of our systems and find that in the straight pipe, hoppers and all parts against which the ashes do not directly impinge the wear is not excessive. Over 18,000 tons of ashes, clinkers and coke passed through the line in ten months and the wall of the straight pipe was reduced less than $\frac{1}{8}$ in. In the bends of the pipe, which are made in four sections, the second section, which leads from the straight line into the curve, is the one that shows the most rapid wear. In this case over 2500 tons of ashes passed the given point before replacement was necessary. The cost of replacing this section is about $10, or 0.4c. per ton of ash handled. It was not necessary to replace the other sections in this particular installation, although 8000 tons has been the limit in other installations.

According to the above data it is estimated that the straight pipe is good for the conveyance of at least 200,000 tons of ashes, and on this basis the depreciation would be about 10 per cent. on the line. This, of course, represents maximum operation, and where the service is less the life of the straight pipe, made from specially hard chilled cast iron 1 in. thick, would be indefinite. In other words, the installation on a 7- or 8-ton-per-day performance, would last longer than the boilers or other equipment which it serves.

Some of the points mentioned by the parties discussing this subject are based on ordinary pipe of the usual thickness which costs more per pound and wears out more quickly, requires additional labor, costs more for upkeep and depreciates more rapidly.

If there is any further information desired, or any direct inquiry made, we shall be glad to give specific data on installations in operation for 18 months.

R. H. MILLER,
Girtanner-Daviess.

St. Louis, Mo.

Live Steam versus Live Men

Here is a copy of a clipping taken from our local paper four years back:

A hearing was held Friday before the committee on labor on the bill which provides for the licensing of steam engineers and the appointment of a chief engineer with a brood of assistants—all drawing live steam from the state treasury. It was supported by a number of engineers and opposed by a number of manufacturers. The committee is expected to blow the whistle for the recall of this bill.

And here is a bit of personal experience in our own city of very recent date by a local engineer:

With a friend I visited a neighboring power plant in which a boiler fifteen or twenty years old was doing duty. The first thing that I noticed was a lever safety valve supporting at the outer end of the lever, not only the weight which went with it, but a six-quart pail containing a varied assortment of bolts, old iron, etc. For the uninformed I will say that this would hold the steam in the boiler to a pressure perhaps twice that for which it was built, or even more, when from its age the pressure should probably not be allowed to exceed two-thirds that for which it was originally designed. Being curious, I asked the engineer (?) what steam pressure he carried. He took me to the steam gage and rapped the pipe a number of times; the pointer each time would find a new position, showing that it was out of order. Also,

there was a gage-glass and only two gage-cocks, but as there was a lively fire under the boiler, I did not care to ascertain if they were working properly, so took a hurried departure, inviting my friend to come along and fearing for the safety of the 25 men working within one hundred feet of this "live steam" which threatened their lives through the gross carelessness or ignorance of the man in charge, the owner or both.

Would it not be well to have a boiler-inspection and engineer's license law on our statute books before we attend the funeral of a friend, or perhaps a son or brother, killed by a boiler or engine accident, even if those who enforce it do draw "live steam" from the state treasury?

I will vouch for the above facts, substantially as presented.

A Connecticut Engineer.

Bristol, Conn.

The Diesel Engine Defended

In the article on "Oil Engine Tendencies" in the Feb. 9 issue we note among the objections which can be raised against the Diesel engine that "it is complicated in design, necessitating strict attention to the minutest details and requires a very high grade of workmanship." We are led to wonder why, and since when, have sound workmanship and conscientious care and attention become objectionable. Surely, it is one of the great merits of the Diesel engine that those who build it thoughtfully bring to bear upon its production the best of brains and labor. No complication of design requires this; the engine is essentially simple. This accuracy of construction and honesty of material and workmanship are demanded by the higher pressures in this class of engine.

By years of experience the reputable and more practiced Diesel-engine builders in Europe have eliminated the troubles first encountered with these higher pressures. The correct practices in four-stroke-cycle design have long since been firmly established, and it is of this knowledge that we availed ourselves when we became the sole licensees of the Swedish Diesel Engine Co., a firm with 17 years' specialized experience.

It is correct to state that close adjustment must be maintained at all times, but Mr. Ward goes astray when he adds that skilled attendance with corresponding high cost is essential. The adjustments are extremely infrequent, for the wear upon these engines is so slow that it does not become sufficiently pronounced to need attention in less than 10,000 operating hours, and frequently more.

The only requirement of the attendance is that it shall be intelligent. The distinction between the terms "skilled" and "intelligent" is important and must be observed. The one implies high wages and difficulties of supply; the other brings the attendance to an ordinary level. With the simple instructions we are issuing for the care and maintenance of our Diesel-type engines any engineer of average clearheadedness will be able to operate them with a maximum of satisfaction, obtaining prolonged and economical service.

The estimate that between 400,000 and 500,000 hp. in the aggregate is supplied by Diesel engines in Europe is far from the mark. The writer made a close computation about 12 months ago and arrived at the total of 1,800,000 hp., but by this date the figure will have been exceeded. The firm which made of Diesel's project a practicable engine and translated his ideas into a sound commercial prime mover has itself sold over 400,000 hp., or as much as Mr. Ward estimated for the lower limit of the total European output.

R. W. Crowly,
McIntosh & Seymour Corp.

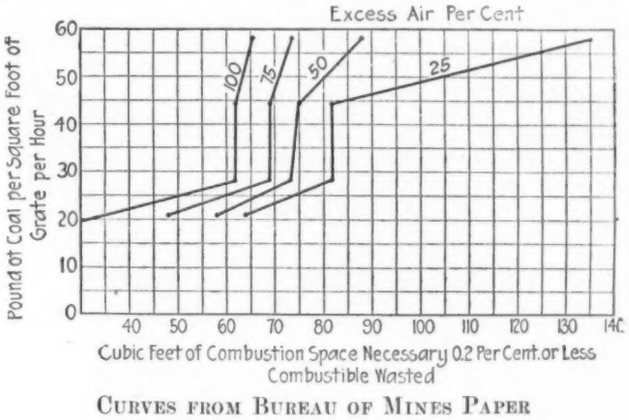
Auburn, N. Y.

Bureau of Mines Paper on Combustion

I have carefully studied the Bureau of Mines Technical Paper No. 63, on "Factors Governing the Combustion of Coal in Boiler Furnaces," and find it interesting. The object and scope of the investigation promise information that engineers are eager to have. It is true that there is a lack of knowledge of the underlying principles of correct furnace design, but perhaps when this investigation is completed there will be available information really useful in practice.

Recorded results show that practically the same amount of combustion space is required for burning both 28.4 and 44.3 lb. of coal per square foot of grate per hour. This is the case for all percentages of excess air. This is more noticeable when presented graphically as shown herewith. It requires about 40 per cent. more combustion space to produce 0.2 per cent. or less combustible in the gases, at a combustion rate of 21 lb. per square foot than at 28 lb.; therefore, it does not seem reasonable that it would require the same space for a rating of 44 lb. as 28 lb. Also, above 44 lb., as is shown by the chart, the space required increases.

This paper shows that a long and spacious combustion space is necessary to allow for complete combustion of



Curves from Bureau of Mines Paper

the gases and increased efficiency. From the bulletin's illustration, Fig. 10, on the variations in furnace conditions during test No. 121, it will be noted that the average temperature at section *G* was about 300 deg. F. less than at section *A*, a distance of about 29 ft. Upon referring to the data on this test it will be found that the rating was exceptionally high, 61 lb. per square foot. Also one figures that the loss caused by the drop in temperature amounts to more than the loss that would result from incomplete combustion.

Furthermore, this loss due to a restricted combustion space occurs for short periods during peaks and would not balance the floor space and investment and maintenance cost of space necessary for complete combustion.

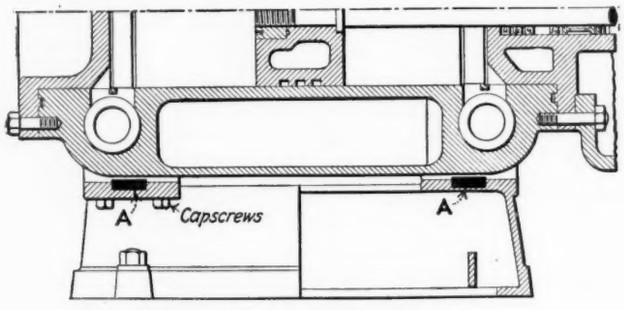
Information on the amount of combustion space needed for certain grades of coals burned at certain ratings is necessary if we are to calculate the investment and maintenance costs.

Meridian, Miss. CHARLES M. ROGERS.

Replacing Broken Capscrews

The letter by C. L. Juno regarding broken capscrews, on page 891 in the issue of Dec. 22, reminds me of a somewhat similar job.

One day it was noticed that one ammonia compressor fastened to its pedestal base with twelve 1¼-in. capscrews was moving a little and that three of the capscrews were broken and most of the others loose. The machine was



KEYS TO TAKE STRAIN FROM CAPSCREWS

shut down, the broken pieces drilled out, as we had plenty of room and good tools, and new capscrews put in.

We soon found two more broken ones, and as time went on it was a common thing to find broken or loose capscrews, and to hold those two compressors steady became a troublesome problem, although we made a new set of capscrews with bodies a snug fit in the holes through the pedestal. Finally, slots *A* were cut 1 in. deep and 3 in. wide at both ends on both sides, making 1x3-in. slots, or keyways, one-half in the pedestal and the other half in the cylinder flange, and extending clear across.

Tight-fitting keys were made and driven into these slots after the capscrews had all been pulled up as tight as possible. This cured the trouble, as the strain was on the wedges instead of on the capscrews.

Chicago, Ill. A. G. SOLOMON.

Mr. Williams' Rejoinder

In the Mar. 2 issue a reference is made to the Hall of Records' test, under the title "Some Dates to Remember," which suggests, at least indirectly, that the New York Edison Co. is endeavoring to withhold the results of the test from publication. On the contrary, we have repeatedly urged that the report be completed and signed at the earliest practicable moment. The test—probably the most complete ever made of a private plant—was conducted under the supervision of a committee consisting of some of our most eminent practical and theoretical engineers, as representatives of the City, the Bureau of Municipal Research and ourselves.

Numerically, the representatives of the Edison company on the committee are in a minority. Quite apart from this, however, the character of those who have been in charge of the proceedings should preclude any suggestion of influence, undue or otherwise, concerning their final action, whether in favor of or against the operation of the private plant or the service of this company. After the completion of the test, some time has been required for analysis and study before the preparation of the report. All this we understand is now practically complete, and it is expected that the report will soon be ready for publication.

Knowing that you would not even unwittingly do injustice either to the gentlemen who have given so much time to this important question or to this company, we feel that you will take such fair means as may be necessary to avoid misunderstanding, through inference or otherwise, from the editorial in question.

ARTHUR WILLIAMS,
General Inspector, New York Edison Co.

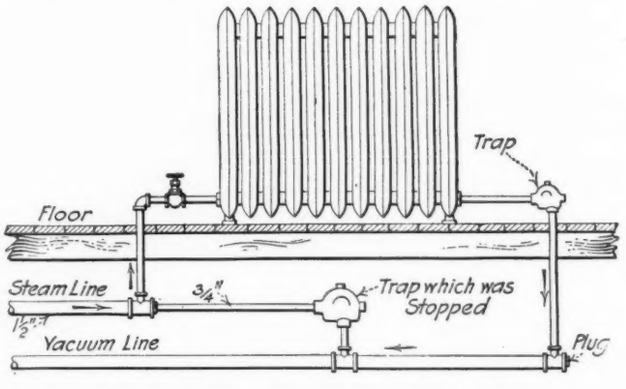
New York City.

[We are glad to learn that Mr. Williams is as anxious as ourselves to see the report on the Hall of Records' test made public. The impression is current that the representatives of and sympathizers with the Edison company on the committee, through zealous efforts to serve their clients' interests, were largely responsible for the delay.—EDITOR.]

Why a Radiator Would Not Work

In part of a direct-heating equipment, a two-pipe radiator connected to a vacuum return system failed to heat. There was about one pound pressure on the steam side and about three inches of vacuum on the return line.

At first the case seemed puzzling, especially as the admission valve and the thermostatic return-end trap proved to be unobstructed and all the other radiators in the building were heating nicely. An examination of the lines leading to this particular unit showed that it was the end one of the series. In other words, it was fed by the



TRAP PREVENTING CIRCULATION OF RADIATOR

extreme end of the steam line and tapped by the extreme end of the vacuum or return line.

As shown in the sketch, a trap had been installed in a jumper across the space beneath the floor where the radiator was, the supposition being that the arrangement would keep this extreme end dry. However, when the cap cover was removed from the trap an old lead pencil was found firmly wedged under the thermostat. This, of course, propped it up and completely destroyed its function. A short-circuit was thus formed, shunting the heating unit entirely. When the obstruction was removed, the trap closed and the radiator promptly warmed up.

Philadelphia, Penn. EDWARD T. BINNS.

Incorrect Diagrams from Compressor

The ammonia compressor was a vertical, two-cylinder, single-acting machine with two cranks at 90 deg., driven by a water turbine. Only one ammonia indicator

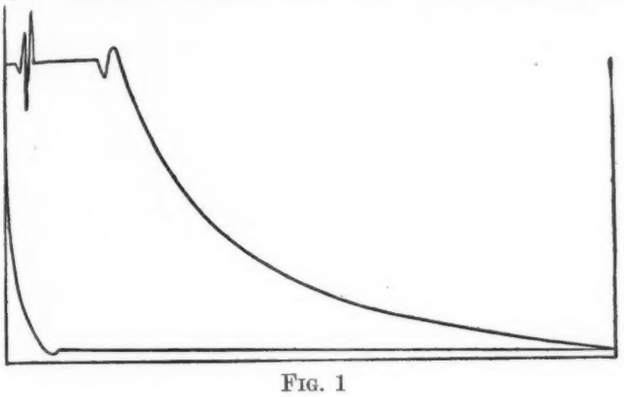


FIG. 1

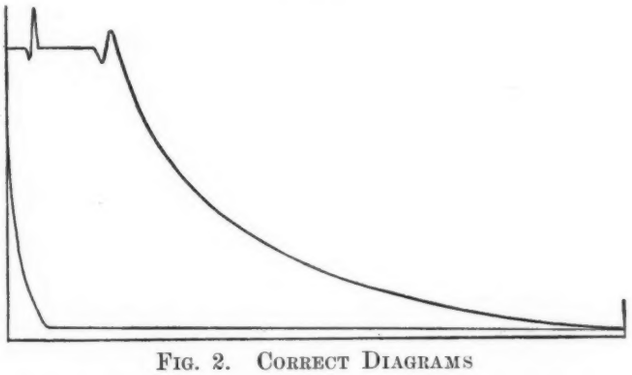


FIG. 2. CORRECT DIAGRAMS

(Thompson type) was available, so pipes were led from the two cylinders to a three-way cock between the two cylinders. As the two cranks were at an angle other than 180 deg. to each other, it was necessary to attach a reducing rig to each crosshead. The two pantographs used, being direct-reducing rigs, caused both diagrams to fall

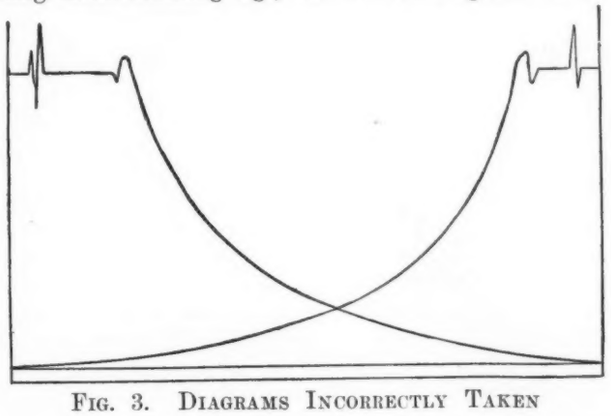


FIG. 3. DIAGRAMS INCORRECTLY TAKEN

at the left end of the card, and made it desirable, if not necessary, to take them from the two cylinders on separate cards. Normal diagrams are shown in Figs. 1 and 2.

During the noon hour while I was away for lunch, the man operating the indicator did some investigating and devised a short cut to suit himself. Finding by experiment that one reducing rig, acting indirectly with respect to the one for the other cylinder, would put the two diagrams on opposite ends of the same card, and forgetting that the function of a reducing rig is to move the indicator drum in time with the piston to which it is attached, he discarded one pantograph and got the diagrams, Fig. 3.

When the pencil point wore down and the diagrams became faint, he unscrewed the handle from the pencil mechanism and jammed the point so hard against the drum that the pencil arm bent sufficiently to catch under the end of the front pedestal shaft and cut off the tops of the diagrams as shown in Fig. 4. No less than half

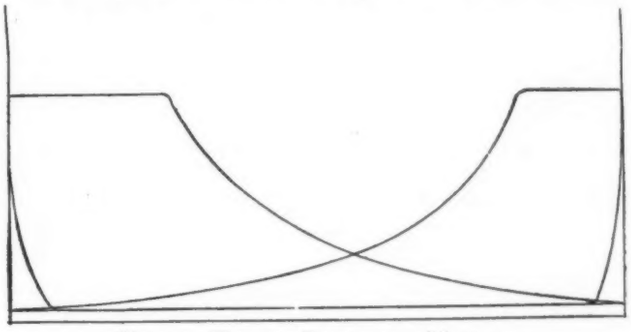


FIG. 4. TOP OF DIAGRAMS MISSING

a dozen such diagrams were taken and delivered to the man operating the planimeter, who integrated the areas and entered them on the log sheet without question.

F. V. LARKIN.

So. Bethlehem, Penn.

Corliss Governor Compensator

The issue of Nov. 24, page 746, describes a device used to assist a flyball governor to maintain the speed of an engine within 1 per cent. from no load to a 25 per cent. overload. It is stated that one of these compensators has been in use for five years, giving good results, and that it should prove of value in rolling mills, sawmills, etc., where the variation in the load is great.

Judging from the illustration and the description, it is my opinion that it would be useless, if not a detriment, even on engines operating with a comparatively steady load.

Suppose the load should suddenly become greater; the reduction in the speed of the engine would cause the governor to drop for a longer cutoff, thus throwing the compensator out of level. This in turn would cause the mercury to shift to the lower end of the tube and by its weight hasten the downward movement of the governor. So far its work is admirable, but what would take place when the extra load goes off?

The governor tends to rise for a shorter cutoff and, in addition to lifting itself, is burdened with the extra weight of the mercury in the lower end of the compensator. This will require a higher speed of the governor and of the engine than if the device were not used.

When the extra load came on and the mercury took the lower end of the tube, the governor would not allow the engine to drop to as low a speed as if the mercury tube were not used. On the other hand, the governor would require a higher speed in order to raise the additional weight to a point where the tube would be level, or inclined the opposite way if necessary. What is gained one way is counteracted in the other, and should the fluctuations in load be great and frequent, the device might prove to be a detriment.

Another statement says the division walls prevent any sudden shifting of the mercury. It seems that to hold the speed within narrow limits the shifting should be sudden, and if the device provided for this in both directions, without the necessity of lifting it at the expense of the speed of the governor after it is once out of level, the results would approach the ideal.

I am inclined to think the description does not cover the ground; that something is omitted that would explain the apparent defect, because if it has been used for five years with good results, we have no right to dispute the statement.

The article also says "it has the same effect as automatically increasing or decreasing the weight of the balls," etc. This is true, but which way will the change in speed of the engine be for a given change in the governor balls? By test, the engine was found to run slower for an increase in the weight of the governor balls and *vice versa,* the dead weight or counterpoise weight remaining unchanged. Therefore, when the tube shifts for a longer cutoff it produces the same effect as if the balls were made lighter, and an opposite shift produces the same effect as if they were heavier.

JOSEPH STEWART.

Hamilton, Ohio.

Using Short Gage-Glasses

Among other things bought in a job lot were about four dozen gage-glasses of good quality but too short for any of our regular connections. I hit upon the following way of making use of them:

The upper packing nut was replaced by a reducing coupling, threaded to suit, into which a short brass pipe was screwed. The lower end of this pipe was threaded to receive a pipe cap, which had been bored out a neat fit over the gage-glass. This formed a good stuffing-box for lower pressure. It happened in this case that the bore of the pipe was just right for the glass, otherwise a washer at the end of the pipe would have been necessary, to form the bottom of the stuffing-box.

Short glasses may be utilized on low-pressure work by using a piece of hose to join the ends wherever they may come, thus forming a flexible joint. Long receiver-tank glasses will often last longer when in two parts than in one.

ARTHUR D. PALMER.

Dorchester, Mass.

Why the Old Engineer Lost His Job

Coming back to Boston after five years in South America, the first thing I did was to visit my old friend, Bill, the engineer. Long before I can remember—in fact, before I was born—he was there at the plant. I had thought many times of him, his big, smiling face, as he sat in a large wooden armchair in the engine-room doorway smoking his old pipe; and he always had a friendly word for us kids.

Arriving at the engine room, I was surprised not to see Bill in the doorway; even the chair was missing. The old engine had been displaced by a turbine, and at the desk was a stranger reading a blueprint.

I asked for Old Bill (I never did know his last name) and was told I would find him in the pipe shop. It made me feel good to hear that he was still at the plant and it did not take me long to cross the yard. The first man I met was Bill, but what a different man!

"Are you Bill, the engineer?"

"Yes—I used to be."

"Used to be; what's the trouble; why are you not now?"

"Well," said he, "the 'Old Man' died and his son took charge a couple of years ago, and that fixed me all right. He put in new machinery and then he wanted me to make tests on the boilers and turbine, and to send a monthly report of everything to the office. I didn't know how to do those things. They got a new engineer, but kept me around the plant, and there you are. Many a time I wish I was dead, as this come-down is awful."

The thought came to me right there, how many engineers of the old school will go the same way, because they don't know!

H. C. HARRIS.

Boston, Mass.

Corrosion of Iron and Steel Pipe

There are no reliable data as to the relative ability of iron and steel to resist corrosion. Furthermore, it is a difficult matter to identify the two materials without the acid-etching test. Some time ago, an engineer with many years' experience in the installation of steam and hot-water heating plants remarked that he could tell whether the pipe was iron or steel by the way a die cut. Some short pieces of pipe were submitted to him to separate the iron from the steel. His attempt met with such indifferent success, as shown by the acid test, that he remarked: "There's one thing certain, I don't know iron from steel."

Besides threading easier, he believed that iron pipe resisted corrosion better than steel. Both these beliefs were shaken when he learned that he could not distinguish between the two.

The popular notion is that if it corrodes easily, it is steel; if it offers considerable resistance to corrosion, it is iron.

Some years ago the purchasing agent for a packing house ordered from the mill a number of bars of strictly wrought iron. There was no wrought iron in the plant, everything being soft and medium steel. The manager had the order filled from the steel stock, saying: "If they discover the difference we'll refund their money and give them the steel." The manager had some misgivings until another order was received from the same agent for more iron. This is an incident of which I have personal knowledge.

Later, I was employed in two different packing houses and was amused by the stories of the wonderful durability of wrought iron and the utter worthlessness of steel under packing-house conditions. There is much difference of opinion among those who ought to know; one makes a test that proves conclusively that steel corrodes faster than iron; then another makes a test that proves the contrary. The only vital difference I have been able to find is in the price, steel being cheaper.

C. O. SANDSTROM.

Kansas City, Mo.

Inquiries of General Interest

Conversion of Heat into Work during Expansion—Why should steam lose any of its heat when expanding and doing work, if it loses none while expanding and doing no work?

W. R. W.

Heat and energy are mutually interchangeable, and when work is done in the process of expansion it is performed not by loss but by conversion of some of the heat of the steam into energy, each heat unit thus transformed being converted into 778 foot-pounds of energy, and as a consequence of the transformation, the remaining heat in the steam must be less than the heat which it contained before doing the work.

Brake Power of Engine—What brake horsepower is developed by an engine when the length of brake arm is 60 in., tare weight of brake 20 lb., total pressure of brake arm 156 lb., and brake wheel makes 200 r.p.m.?

T. R.

The brake horsepower is given by the formula

$$\frac{\text{Length of brake arm in feet} \times 2\pi \times \text{net weight or pressure lb.} \times \text{r.p.m.}}{33{,}000}$$

hence there would be

$$\frac{\frac{60}{12} \times 2 \times 3.1416 \times (156 - 20) \times 200}{33{,}000} = 25.89 \text{ b.hp.}$$

Metering Fuel Gas at Different Pressures—What would be the relative weight of equal volumes of fuel gas measured by a volumetric meter at 8 oz. and at 12 oz. pressure?

R. V. S.

For the same temperature the density would be directly as the absolute pressure. Taking the pressure of the atmosphere at 14.7 lb., or 235.2 oz., per sq.in., and assuming the gas pressures are quoted in ounces per square inch in excess of atmospheric pressure, then for 8 oz. pressure the absolute pressure would be

$$235.2 + 8 = 243.2 \text{ oz.}$$

and for 12 oz. pressure it would be

$$235.2 + 12 = 247.2 \text{ oz. per sq.in.,}$$

hence, a given volume metered at a pressure of 12 oz. would be $\frac{247.2}{243.2}$ as much or about 1.6 per cent. more than when metered at a pressure of 8 oz. above atmospheric pressure.

Weight of Plunger When Submerged—When submerged in water, what would be the weight of a hollow bronze pump plunger 18 in. in diameter by 70 in. long, having ends 4 in. thick and sides ¾ in. thick?

S. C.

The weight immersed will be the difference between the weight of the plunger in air and the weight of the volume of water displaced. The volume displaced would be $(18 \times 18 \times 0.7854) \times 70 = 17{,}812.9$ cu.in., and taking the weight of water as 0.0361 lb. per cu.in., the weight of water displaced would be $17{,}812.9 \times 0.0361 = 643.046$ lb. The hollow part of the plunger being a cylinder 16½ in. in diameter by 62 in. long, the net volume of metal would be

$$17{,}812.9 - [(16\tfrac{1}{2} \times 16\tfrac{1}{2} \times 0.7854) \times 62] = 4555.7 \text{ cu.in.}$$

and taking the weight of bronze as 0.3195 lb. per cu.in., the weight of the plunger in air would be

$$4555.7 \times 0.3195 = 1455.55 \text{ lb.}$$

so that the weight of the plunger submerged would be

$$1455.55 - 643.046 = 812.51 \text{ lb.}$$

Effect of Short-Circuit in Field Coils of Alternator—What would be the effect of a short-circuit in the field coils of an alternator?

W. C. R.

It would depend somewhat upon the windings and the way they are connected. If the machine is either one-, two- or three-phase there would be a decrease in the voltage. If the windings of the three-phase machine are delta connected there will be local current set up in them which may be so serious as to cause overloading that would affect the lights connected to the machine. One ground in the field, with the rest of the system insulated, would have no effect, but if combined with a ground on some other part of the circuit it would cut out one or more of the field coils.

Origin of "Horsepower"—What is the origin of the term horsepower?

R. C.

Before the introduction of steam engines, the work of horses was employed for driving mills, pumps and other machinery, and the power required for their operation was commonly expressed in the number of horses required, and numerous estimates were used for the average working power of a horse. For rating the power of their steam engines Boulton and Watt adopted an estimate based upon their observations of the power of strong draft horses employed 8 hr. per day at London breweries. They found that a horse was able to go at the rate of 2½ miles per hour and at the same time raise a weight of 150 lb. by means of a rope led over a pulley, and the rate of work performed, viz.,

$$\frac{2\tfrac{1}{2} \times 5280 \text{ ft.} \times 150 \text{ lb.}}{60} = 33{,}000 \text{ ft.-lb. per min.}$$

thus established as a horsepower, has been continued as the standard among English-speaking peoples.

Size of Common Exhaust Pipe—What is the rule for finding the diameter of a common exhaust pipe for engines having, respectively, 4-in., 6-in. and 7-in. exhaust connections without materially increasing the back pressure?

P. E. M.

The relative flow of steam of the same density in different pipes varies as

$$\sqrt{\frac{d^6}{d + 3.6}}$$

in which d = diameter in inches. Assuming that the exhaust is at the same pressure in each pipe at the point where they are joined together, then without materially altering the back pressure from what it would be from an equal extension of each exhaust pipe, the diameter of the common exhaust pipe would be the value of d in the equation

$$\sqrt{\frac{d^6}{d + 3.6}} = \sqrt{\frac{4^6}{4 + 3.6}} + \sqrt{\frac{6^6}{6 + 3.6}} + \sqrt{\frac{7^6}{7 + 3.6}} = 198.27$$

By assigning different values to d the nearest even pipe size required is found to be between 9 and 10 in. and therefore a common exhaust pipe of 10 in. diameter should be employed.

Capacity of Closed Water Heater—What quantity of water can be heated from 60 deg. F. to 180 deg. F. by a sufficient supply of exhaust steam at 4-lb. gage pressure in a closed heater containing 21 three-inch iron U-tubes having an average length of 16 ft.?

P. B. B.

Standard 3-in. iron lap-welded boiler tubes have an internal diameter of 2.782 in., and the heating surface would amount to

$$\frac{2.782}{12} \times 3.1416 \times 16 \times 21 = 244.72 \text{ sq.ft.}$$

Taking the average temperature of the steam as 218 deg. F., and average temperature of the water as 120 deg. F., the average temperature difference would be 98 deg. F., for which there would be a condensation of about 18 lb. of steam per square foot of pipe surface per hour, and as each pound of steam would liberate about 966 B.t.u., the total heat transmitted to the water would amount to

$$966 \times 18 \times 244.72 = 4{,}255{,}191 \text{ B.t.u. per hr.}$$

and as each pound of water raised from 60 to 180 deg. F. would require

$$180 - 60 = 120 \text{ B.t.u.}$$

there would be

$$4{,}255{,}191 \div 120 = 35{,}459.9 \text{ lb.}$$

or about

$$35{,}456 \div 8.33 = 4256 \text{ gal. of water heated per hour.}$$

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—EDITOR.]

Hearing on Massachusetts Licensing Bill

Several hundred engineers and firemen attended a hearing at Boston, Mass., on Mar. 10, given by the legislative committee on mercantile affairs upon House Bill 1111, a measure introduced by various interests to render the licensing of engineers and firemen easier than under the present law. The hearing was one of the most hotly contested of the session, operating engineers from all parts of the state registering their opposition to the proposed changes in the law.

ABSTRACT OF THE BILL

The bill provides that to be eligible to apply for examination for a fireman's license, a person must have been employed as a fireman for not less than one year. The examination must be of a practical character, to ascertain whether the applicant has thorough knowledge of the functions of a steam boiler and its appurtenances, of the proper methods of operation and cleaning, how to proceed in case of accident, low water, or in the event of signs of distress; of packing handholes, manholes, valve stems and pipe flanges, and of the proper condition and management of boilers and their accessories, including pumps and other feeding devices.

Steam engineers' licenses are required by the bill in the operation of all engines of 25 hp. and over, with the usual exceptions of railroad locomotives, agricultural engines, etc., instead of the 9-hp. limitation of the present law. Thirty days are allowed for evidence of a second violation, in place of one week as at present. To be eligible for a first-class engineer's license, a person must have held a second-class license or must have been in charge of an engine or engines of over 150-hp. rating each, for a period of not less than two years, or must have served as a steam-engine erector, mechanical engineer or master mechanic of a plant having an engine or engines of over 150 hp. rating each, for not less than three years. The examination for a first-class engineer's license is required to be of a practical character to show whether the applicant has thorough knowledge of the construction, proper care and safe operation of steam engines and their appurtenances.

A second-class engineer's license entitles a steam engineer to have charge of any steam engine or engines not exceeding 150 hp. each, under charge of a first-class licensed engineer. To be eligible for a second-class license, a person must have operated a steam engine or engines for not less than one year, or must have served as a steam-engine erector, mechanical engineer or as master mechanic for not less than two years. The examination covers about the same range of topics as for a first-class license with the exception that knowledge of engine construction is not required. A person seeking a third-class engineer's license may take an examination upon presentation of a request signed by the engine owner or user, such license entitling the holder to operate a particular engine or engines without limit as to size. In other particulars the bill generally follows the existing law. It provides for the retention of all existing licenses and for their exchange, when desired, for licenses under the new law, according to a tabulation which need not be reproduced at this time.

Edward P. Butts, chief engineer of the American Writing Paper Co., Holyoke, the original petitioner for the bill, was the first speaker. He pointed out that under the present law engines and boilers are held to be equal as hazards. He contended that the boiler presents the greater risk, indicated by the fact that most boilers are insured against accident, but comparatively few engines. Constant attendance, he held, is essential in the boiler room, but not at the engine. The present law is complex, in his opinion, and the petitioners object strenuously to the lack of uniformity in examinations for licenses. The character of the examinations depends too much upon the discretion of local inspectors and is frequently too technical. Mr. Butts contended that firemen should not be examined on points in boiler construction nor engineers on details of engine design, claiming that the examiners should ascertain merely whether a man is competent to run the equipment without any extended theoretical knowledge of it. He held it to be unfair to owners of plants using water power a large part of the year to require them to hire skilled engineers for twelve months, when steam-auxiliary service may be needed only for two or three. Another point which the bill is designed to care for is the elimination of the first-class engineer as a necessity to the operation of portable engines. Connecticut has no such license law as Massachusetts, and the speaker contended that the operation of engines and boilers is just as safe there as in the Bay State.

William McCorkindale, Holyoke, representing the Parsons Paper Co., attacked the questions given candidates for a second-class engineer's license on the ground that they are too technical. In a specific instance one candidate failed through inability to tell the examiners the physical properties of steam, the ratio of expansion in turbine blades, and why a fusible plug melts when low water occurs in a boiler.

C. A. Crocker, Chemical Paper Manufacturing Co., Holyoke, said that too much discretion in the enforcement of the existing law is placed upon the inspectors in local districts. He felt that the bill provides as well for safety as the existing law and pointed out that a man to have charge of a large plant should not necessarily have a fireman's license.

James O'Brien, Lee Marble Works, Lee, said that the present law requires his concern to put a steam engineer on each channeling machine because the engine is rated at 12 hp. This, he said, has been a great embarrassment, because specially trained men are required to operate channelers in quarries. Under the present law he could not even utilize the services of the manufacturer's erectors in the operation of channelers. He cited the case of an experienced erector employed by the Sullivan Machinery Co., Claremont, N. H., to instruct Russians and other purchasers in the use of channelers made by this company. This erector could not obtain a Massachusetts license because he was unable to answer purely technical questions about steam engineering. The present law limits engines to 9 hp. without a licensed engineer, and the speaker urged that a 25-hp. limit be adopted. He said that at present a man with a third-class license could run a single engine not exceeding 50 hp. in rating, but if such a machine broke down and the employer wanted to run two 10-hp. engines or two 25-hp. engines by the same man, there would be a violation of the statute.

Mr. O'Brien said that these restrictions made it much harder for Massachusetts companies to compete with concerns in other states and led indirectly to the employment of fewer engineers than would be the case under the proposed law. Thus, in Georgia, no license is required to operate quarry machines by steam, and there is no law in Vermont which licenses engineers and firemen. He thought that in these industrial plants special licenses should be given in many cases. He said that in the paper industry conditions are fully as troublesome through the present law, which may force electrification of many mills if operators of paper machines are not allowed to start and stop their steam-driven apparatus without the immediate supervision of licensed engineers. The ruling of an inspector now on duty in the Connecticut Valley, that a certain mill should employ a steam engineer for each paper machine, threatens to increase the payroll by $300 per week.

George P. Gilmore, an engineer with the American Printing Co., Fall River, brought out the point that the number of engineers' licenses issued has fallen from 97 first-class in 1911 to 62 in 1913, and from 186 second-class to 115. He stated that there are 1726 first-class licenses outstanding in Massachusetts today and 1796 second-class. At the present rate of increase it will take twenty-eight years to replace the present number of first-class engineers and eighteen years to replace the second-class men. He objected vigorously to the absence of any appeal from the decisions of the examining board.

Capt. White, Lowell Paper Tube Corporation, Lowell, contended that the law should specifically limit the powers and scope of examiners. Requirements for licenses should be definite, as in the Navy, where the speaker had spent 36 years. The naval examination of firemen is always oral and purely practical. Capt. White bewailed the fact that a man can fire a torpedo-boat boiler and still be unable to get a fireman's license for a Massachusetts stationary plant.

Frank Dresser, American Steel & Wire Co., Worcester, pointed out that in his opinion the bill does not impair safety. The United States Steel Corporation does not consider the holder of an engineer's or fireman's license as necessarily qualified for plant operation. The company desires to know what sort of an examination was given and does not favor the present non-standardized methods. Knowledge of stresses in steel is unessential to the proper handling of power plants, the speaker contended. The company at present employs 125 engineers and firemen at Worcester, and in normal business periods 200.

Frederick M. Ives, for the Massachusetts Electric Lighting Association, Boston, also favored the bill.

Clifford Anderson, for the Norton Co., Worcester, said that one of the best engineers in the state operates a 250-hp. steam engine, a 500-hp. gas engine, and a 1000-hp. steam turbine in the company's plant, on a special license. This engineer, who has maintained the engine service for twelve years without a minute's loss of time, who has run the gas engine with a loss of only 0.5 per cent. in working time, and who has run the turbine unit one year and three months without a moment's stoppage due to machinery trouble, cannot get a first-class license in any other plant because of his

inability to answer highly technical questions put by the examiners. The speaker attacked the present law on the grounds that it keeps out competent men, and he criticized examinations upon theoretical points.

Samuel M. Green, Springfield, Mass., consulting engineer, appeared on behalf of the Springfield Board of Trade and a large number of paper and other manufacturers in the Connecticut Valley. He said that his clients do not consider that the Massachusetts license is an index of a man's ability to operate a given plant and that often the examinations contain foolish questions. The bill stipulates that the examination of both engineers and firemen shall be of a distinctly practical nature. Mr. Green stated that the American Society of Mechanical Engineers has been considering a standard set of regulations governing the licensing of engineers and firemen, but that it had withdrawn the plan of closely following the Massachusetts law in this respect. The speaker contended that there are numerous inconsistencies in the present law which work hardships to the plant owner. Thus, the law now holds that an engine of over 50 hp. must be operated by a man with a second-class license. By reducing the speed of a 60-hp. engine on a paper machine 15 per cent., for example, its rating may be cut down so that it can be run by a third-class engineer. In one plant the owner employed a technical graduate as plant engineer. He was refused a license because he had not fired a boiler for a year. At the Hotel Kimball, Springfield, an engineer from New York State was refused opportunity to take the Massachusetts examination because he had not resided in the latter state for from four to six weeks. Mr. Green contended that firing is not an essential preliminary to an engineer's job.

OPPOSITION TO THE BILL

A. M. Huddell, Boston, who said he represented 13,000 men affiliated with the Massachusetts branch of the International Union of Steam and Operating Engineers, maintained that the bill jeopardizes public safety and contended that while uniform examinations and uniform enforcement of the present law are desirable, the present bill should not be substituted. If the bill passes, third-class plants will be legislated out of existence. Mr. Huddell attacked the provision of the bill allowing thirty days to pass instead of the present seven after an inspector has found a plant improperly manned, before a violation can be charged. He said that an inspector ought to be permitted to enter a plant at any hour rather than at a so called "reasonable" hour, as stated in the bill. Manufacturers can get all the relief they desire from the present law if it is properly enforced. The speaker advocated the establishment of a mechanical department separate from the District Police, who now enforce the boiler and engine laws of the state.

D. G. Kimball, Roxbury, Mass., representing the National Association of Stationary Engineers, said that the entire plant should be in charge of the chief engineer, whereas the bill tends to divide the responsibility of the plant between the engineer and the fireman. He protested vigorously against lowering the standard of the examination and set forth the importance of an engineer's acquiring a broad knowledge of his profession, including both theory and practice. "Our aim," said Mr. Kimball, "is to enable an engineer to rise higher in his work. He should study and keep up with his trade, and we favor the present law because it tends to that end."

C. C. Harris, Springfield, Mass., president of the Brotherhood of Power Workers, held that it is unsafe to place a man in charge of a steam plant unless he knows something of the construction of engines. He cited instances of accidents to paper-mill steam-driven machinery through the mishandling of the equipment by unlicensed men. Failure to drain the pipes in one case cost two lives, through an explosion which followed suddenly turning on steam.

Thomas Hawley, head of the Hawley School of Engineering, Boston, was a vigorous opponent of the bill. Mr. Hawley said that the present law had served well for over twenty years; that it had led to great improvements in the handling of plants and had enormously diminished the number of explosions, besides raising the caliber of engineers and firemen. The proposed measure does not provide any really easier examinations and is a step in the wrong direction. The speaker ridiculed the inconsistency of the bill in requiring a man to work a year as a fireman before getting a fireman's license. The present law permits a man to start in as a helper. A way must be provided by which a man can enter the business.

The speaker pointed out that the present examinations are practical. Thousands of firemen have been examined on the operation of boilers and not on their responsible care. Under the terms of the bill a man practically unqualified could be put in control of equipment on which he has not been examined. The examinations are not unduly difficult. The speaker favored requiring that the applicant be able to understand the English language before a license be granted. In the Slater Mills, at Webster, Mass., a disastrous explosion occurred because a fireman who did not understand English closed a stop valve instead of opening another valve, as ordered. "Trick" questions are not used in the examinations. Mr. Hawley said that the bill is unnecessary; that a line must be drawn somewhere in establishing the limits of engine size for a new class of license, and pointed out that just above and below such a line there is always room for complaint. He condemned as particularly dangerous the section of the bill providing that a third-class license can be issued to enable a man to operate any particular steam-engine plant, there being no limit on size here. A man has to get a job before he can get a third-class license, under the bill. Special licenses are troublesome and should be discouraged. Mr. Hawley brought out the point that familiarity with marine engines and boilers by no means fitted a man to run stationary plants. Torpedo-boat equipment, for example, is different from that of a factory or central-station plant. In one case a navy fireman knew nothing about the location of the fusible plug in a stationary boiler.

T. N. Kelly, Lowell, Mass., criticized the division of responsibility between the fireman and the engineer and said that under the present law an extra first-class fireman's license provides for correcting local differences due to water-power service a part of the year. H. M. Comerford, Boston, took the same ground.

Capt. George Dimand, Lawrence, Mass., opposed the bill on the ground that it would work hardship to both employer and employee. Division of authority between engine room and fire room is most undesirable. The bill would allow any fireman after running one year to take charge of any boiler plant. This is an insufficient time for a man to grasp the operation of the plant as a whole.

The bill was also opposed by Elmer Stevens, Cambridge, Mass., representing the New England Power League. He contended that the personnel of engineers in Massachusetts has improved under the existing law, emphasized the fairness of the present law, and touched upon the certainty of a square deal in examinations. The committee reserved its decision.

The Computation of a Rate

At the recent convention of the Indiana Engineering Society H. O. Garman, chief engineer of the Public Service Commission of Indiana, discussed a simple method of computing a rate, which was thought fair and reasonable to the different classes of consumers and would give a reasonable return to the investor. As expressed by Mr. Garman, the difficulty now with a great many rates placed on file with the commission by the utilities is that they are too complicated for the ordinary consumer to understand. In many cases the latter, in trying to choose, for instance, an electric rate, is compelled to give up in despair and seek the advice of an expert in selecting a rate that will be economical. The ordinary user is completely lost when he comes in contact with such terms as "load factor," "connected load," "maximum demand," "assessed demand," "measured demand," "off-peak load," "fixed charges," readiness-to-serve charge," "energy charge," etc. The tendency now is toward a simplified rate schedule which can be more nearly understood by the ordinary consumer.

The rate evils, as they have been discovered in Indiana, are not so much rates that are unreasonably high as they are rates that are grossly discriminatory. The unjust discriminations have been brought about by competitive conditions and by lack of publicity.

The failure of the general public to realize that there is a "readiness-to-serve charge" gives rise to a great deal of dissatisfaction. When they can be educated to understand that there is such a charge, they see why it is necessary to charge the small consumer at an apparently higher rate than the larger one. The former feels that he is being persecuted because he is a helpless small consumer, when, in fact, in many cases it would not be possible to furnish him service at all at a rate within his reach were it not for the large user.

Those officers of the public upon whose shoulders falls the duty of fixing these rates are becoming convinced that more simplicity is needed. It works out better to have rates that are less scientific, so called, and more easily understood by the greater number of consumers; and after all, the utility is not so much interested in a scientifiic rate as it is in the gross return that a rate will bring. In other words, what seems to be needed most in rate schedules is less scientific obscurity, a reasonable gross income to the utility and more simplicity and uniformity for the consumers.

Every correct rate should take into account three elements of cost to the utility: Readiness-to-serve cost, energy cost, and customer's cost. Some of the elements of cost entering into readiness-to-serve cost are: Interest return on agreed valuation, rentals, part of allowance for obsolescence, taxes, insurance, and part of the operating costs. The energy cost is made up principally of the so called operating costs, while the customer's cost is made up of items that are directly traceable to the customer, such as reading meter, billing, collecting, testing meter, and the like.

To make the rate matter clearer to the ordinary consumer, an example will be taken by way of illustration. Assume, for instance, three classes of consumers of electricity—power, stores and residences. Assume the cost per kilowatt of demand per month to be $1,20, $3.40 and $4.60, respectively. Assume the energy cost to be $0.01 per kilowatt-hour and the customer's cost per month to be $0.40. Then a table can be computed showing the varying cost per kilowatt-hour, as the hours' use of the demand varies from 15 min. to 24 hr. in one day.

VARYING COST PER KILOWATT-HOUR AS TIME OF USING DEMAND VARIES

Hr. Use of Demand in 24 Hr.	Cost per Kw.-hr, Power	Stores	Residences
0.25	$0.223	$0.517	$0.677
0.50	0.117	0.266	0.346
1.00	0.063	0.137	0.177
1.50	0.046	0.094	0.121
2.00	0.037	0.073	0.093
3.00	0.028	0.052	0.066
4.00	0.023	0.042	0.052
5.00	0.021	0.035	0.043
6.00	0.019	0.031	0.038
7.00	0.018	0.028	0.034
8.00	0.017	0.026	0.031
9.00	0.016	0.024	0.029
10.00	0.015	0.023	0.027
11.00	0.015	0.022	0.025
12.00	0.014	0.021	0.024
24.00	0.012	0.015	0.017

Mr. Garman was well aware that there were many conditions and kinds of service which would seem to justify a multitude of rates, all of which might stand the test of fairness and reasonableness, but in the practical administration of a rate schedule it seemed best to take advantage of averages and work toward simplicity of schedule.

Heating Boiler Bursts

A heating boiler being installed in the new Country Club building by the C. C. Hartwell Steam Fitting Co. burst Mar. 3 on being tested, according to a New Orleans (La.) correspondent. Robert Snow, in charge of the job, was badly scalded, though he may recover. That he was so seriously injured was thought to be due to his heroism in forcing his way to the cutoff valve so as to shut off the steam. But for this action it is considered likely that Ernest Keppler, a helper, who sprained his ankle in trying to get away from the danger, would have been scalded to death. Joseph Martinez and William L. Purduit, also employed on the installation, sustained burns of the face and hands.

Snow and his helpers had just completed the erection of the boiler, and in making a test the pressure had been raised quickly to capacity. It was stated that the workmen, relying on a larger factor of safety than seems to have existed, raised the pressure past capacity for the sake of a thorough test.

BUSINESS ITEMS

The E. Keeler Co. of Williamsport, Penn., has been awarded a contract for 18 water tube boilers by the Illinois State Board of Control. Nine of these are 300 hp. and nine 400 hp., with automatic stokers.

The Buffalo Forge Co., Buffalo, N. Y., is sending out a new catalog (No. 201) on Niagara Conoidal Fans. It contains many illustrations of actual installations, complete tables for capacities, speeds and horsepowers for all sizes of fans, as well as dimensions and characteristic curves. Copies are sent to consulting engineers, manufacturers, architects, etc., on request.

The Yarnall-Waring Co., Chestnut Hill, Philadelphia, has just received orders for four "Lea" V-notch recording liquid meters in combination with Webster feed water heaters aggregating 1,125,000 lb. per hour capacity, from E. I. duPont DeNemours Powder Co., Wilmington, Del., following original installation of "Lea" system by them two years ago. Also an order for a 275,000 lb. per hour capacity "Lea" V-notch recording liquid meter for the new power plant of the Victor Talking Machine Co., Camden, N. J., following the installation of a 150,000 lb. per hour "Lea" instrument by them two years ago.

OBITUARY

WILLIAM H. ARMSTRONG

William H. Armstrong, Grand Worthy Chief of the Universal Craftsmen Council of Engineers of the World, died Mar. 16, at St. Rose's Hospital, New York City. He was one of the best known operating chiefs in the engineering profession, in both land and marine service. He was for many years chief engineer of the Rogers Peet Co. Building at Broadway and Warren St.

Mr. Armstrong was an active member of a number of engineering organizations, including Elmer E. Chambers Council, No. 5, U. C. C. of E.; Stephenson Association, N. A. S. E., and the United Engineers of Greater New York. He was Past Master of Ocean Lodge, No. 156, F. & A. M.

PERSONALS

W. H. Hoyt, C. E. 1890, College of Engineering, University of Minnesota, member of the American Society of Civil Engineers, assistant chief engineer of the Duluth, Missabe & Northern R.R., has been elected president of the Minnesota State Surveyors' and Engineers' Society.

Maj. A. B. Blevins, president of the North Louisiana Interurban & Electric Co., died from heart failure Mar. 4 at his home in Shreveport, La. He was the founder of the Town of New Birmingham, Tex., and one of the earliest developers of the iron-ore region of Texas. He went to Louisiana in 1912 and had been working ever since on the interurban line which is to connect Shreveport and Monroe, La.

ENGINEERING AFFAIRS

The American Boiler Manufacturers' Association has called a meeting of boiler manufacturers and others interested, to approve the code of uniform boiler specifications recently completed by the American Society of Mechanical Engineers. The meeting will be held at the Fort Pitt Hotel, Pittsburgh, Penn., Mar. 29, at 10 a.m.

Boston Engineers' Club announces the following program for the coming month: Thursday, Mar. 25, 1915, "Locomotives, Ancient and Modern," illustrated talk by George W. Stetson; Thursday, Apr. 1, 1915, Franklin A. Snow will describe some of his contracting experiences in South America; Thursday, Apr. 8, 1915, "Butte, Montana," an illustrated talk on modern mine development and operation, by George A. Packard; Thursday, Apr. 15, 1915, "Trees in Spring," illustrated talk by George Winthrop Lee; Thursday, Apr. 22, 1915, "Autogenous Welding and Cutting by Means of the Oxy-Acetylene Torch," illustrated talk by Henry Cave.

University of Illinois Notes—Prof. C. R. Richards, of the department of mechanical engineering of the University of Illinois, has designed a hydraulic absorption dynamometer, several of which have been built in the college shops. One is to be connected to the new 60-hp. six-cylinder Peerless automobile engine in the mechanical engineering laboratory. The engineering experiment station is conducting tests of various building materials to determine their coefficients of heat transmission. The work is being done by L. C. Lichty, research fellow, under the direction of Prof. L. A. Harding, of the department of mechanical engineering. The results of the tests are expected to be of especial value to heating and ventilating engineers. Apparatus for testing steam nozzles has just been installed in the mechanical engineering laboratory. Prof. O. A. Leutwiler and Messrs. H. W. Waterfall and A. B. Domonoske, of the department of mechanical engineering, are conducting an interesting series of tests on a friction clutch for the purpose of determining the relative value of different commercial materials used for clutch linings.

Accidents Due to Poor Lighting—That fully 25 per cent. of the accidents to workmen are caused by insufficient lighting for men working at night, is the opinion of experts who have made a study of the subject. It is estimated that $250,000,000 is the average annual cost of injuries to workmen in the United States alone, and that over 50 per cent. of these accidents are preventable.—"Popular Mechanics."